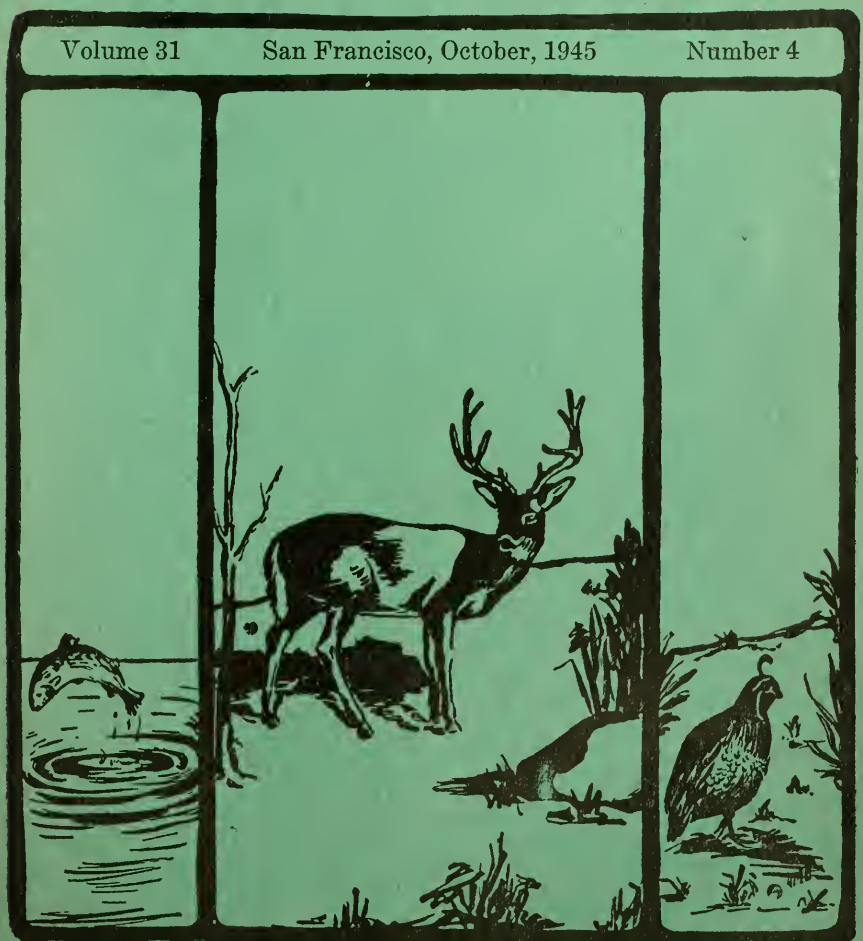
CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 31 San Francisco, October, 1945 Number 4



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CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wildlife. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Brian Curtis, Editor, Division of Fish and Game, Ferry Building, San Francisco 11, California.

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47368

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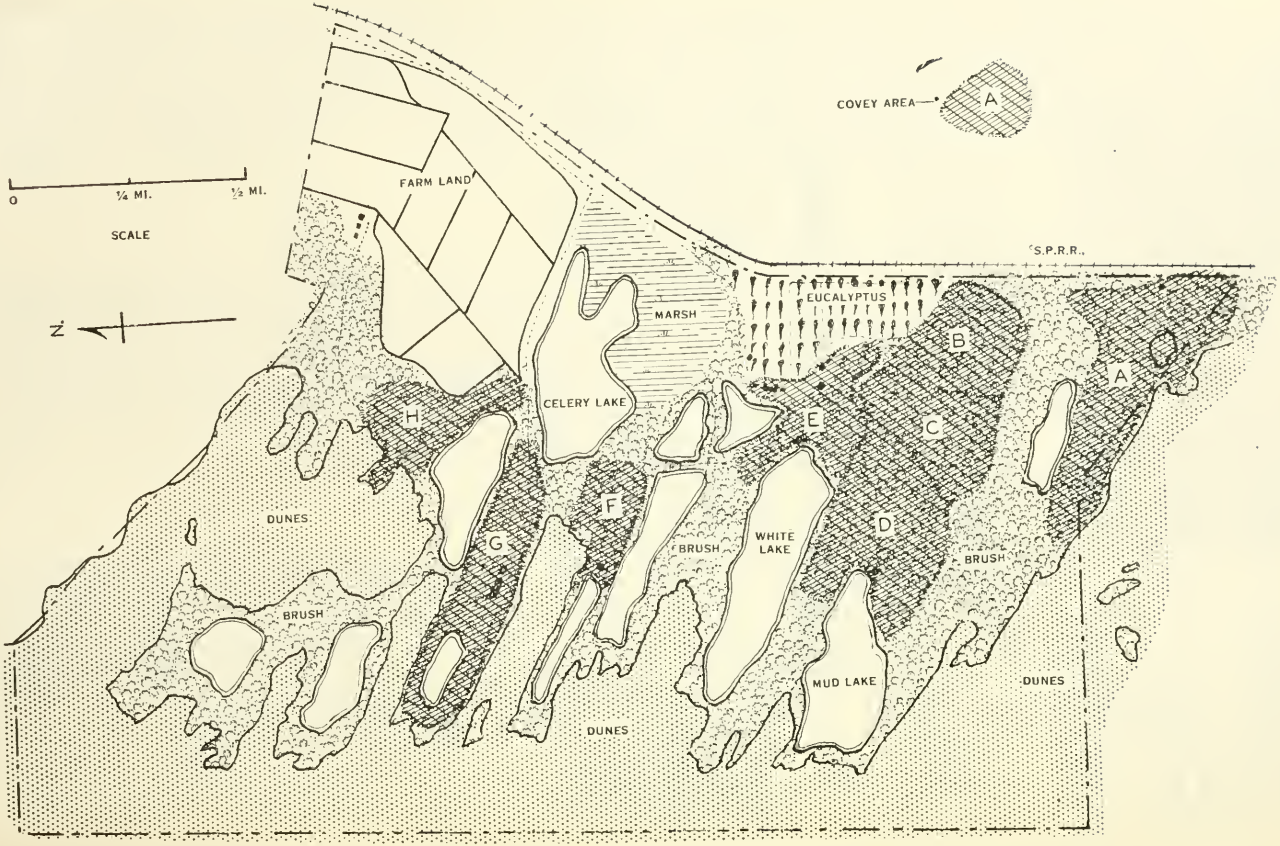

FIG. 51. Map of Dune Lakes Club, San Luis Obispo County, showing various land types and quail covey areas as observed in the fall of 1941.

VALLEY QUAIL UNDER PRIVATE MANAGEMENT AT THE DUNE LAKES CLUB [1]

By Ben Glading, David M. Selleck, and Fred T. Ross
Bureau of Game Conservation
California Division of Fish and Game

Valley quail (*Lophortyx californica*) are nonmigratory. Their lives are usually spent within a few hundred yards of the place where they were hatched. Hence, their management and increase is best effected by building up their numbers locally, on the land on which they are to be hunted.

How private owners of quail shooting land can be successful in building up quail populations is best exemplified by the Dune Lakes Club quail program at their grounds in San Luis Obispo County. Here, private management has resulted in enormous numbers of quail and a sustained bag yield over a series of years.

The Dune Lakes Club is located in the sand dunes and adjacent lands along the southern coast of San Luis Obispo County. The total size of the club is roughly 1,600 acres, although the part suitable for quail and hunted by the owners does not exceed 450 acres (see Fig. 51).

Prior to 1928, a group of sportsmen from Santa Maria used the ponds for duck shooting. While a few quail were present, the area was not particularly noted for this type of hunting. When the Dune Lakes Club took over the property in 1928, two moderate-sized quail coveys existed, one near the present headquarters and barns, and one near an old house at the north end. Best local estimates indicate that not over 200 quail existed at this date. No quail hunting was allowed until 1935.

During the period prior to 1935, some quail were introduced and extensive feeding and predator control operations were conducted. Starting in 1935, quail hunting was allowed and an accurate record kept of the total numbers shot (Table 1). The increasing yield of birds attracted the attention of biologists of the Division of Fish and Game. Through the kind invitation of the club members, the division was privileged to observe and conduct studies of the quail on the club's grounds during the period from December 1940, to 1943.

During the years from 1935 to 1941, the management of quail and ducks was under the direction of one full-time employee of the Dune Lakes Club, aided the year around by one half-time assistant. After 1941, war conditions considerably reduced the manpower employed and the degree of management was much less intense.

The Dune Lakes property is a strip about two miles long by one mile wide, consisting of active and retired sand dunes. Roughly half of the

[1] Submitted for publication, June, 1945.

The authors are indebted to the owners of Dune Lakes, Ltd., Messrs. William Dickinson, Harold Chase, and Peter Bryce, for their cooperation in allowing us to conduct observations on the game at the Dune Lakes Club, and to Messrs. Paul Haddox and L. G. Barker, employees of the club, who aided materially in the conduct of our studies.

The Dune Lakes Club was used as one of the experimental areas of Federal Aid in Wildlife Restoration, Project California 6-R, The Management of Valley Quail in the South Coast Counties of California.

total of 1,600 acres involved is in bare, active dunes. The balance of the area is divided among lakes, marsh, eucalyptus grove, farm land, and brush land. The bare dunes, lakes, and marsh are totally unsuited to quail. During the nesting season some few pairs are to be found in the eucalpytus grove and in the farming ground if the season's crop affords adequate cover. Generally speaking however, quail are confined to about 450 acres of brush land, or rather to the parts of the brush land which are under intensive management. The actual observed range of fall coveys was 286 acres in 1941.

The country surrounding the club is such that few quail are present; hence the possibility of widespread movement of birds from other areas does not exist. On the entire northwest, west, and most of the south boundaries are areas of bare sand dunes adjacent to the ocean; on the north and northeast boundaries are the truck farms of the Arroyo Grande Valley which support a very low quail population. An extensive series of eucalyptus groves, which are almost a biologic desert, forms most of the eastern boundary. The southeast corner abuts on heavy brush land that supports a low quail population.

FIG. 52. View from Dune Lakes headquarters looking over the Bolsa Chica Lake and White Lake. Covey E ranges into the left foreground.

The brush at the club covers old dunes, which give a rolling character to the topography. Except on the flat farming land and marsh, the soil is extremely sandy. Lacking humus, it does not hold water, and hence many plants common to brush lands in other parts of the State can not exist.

The dominant brush species is heather goldenbush (*Haplopappus ericoides*). Other common species of brush are tree lupine (*Lupinus arboreus*), dune lupine (*L. chamissonis*), deerweed (*Lotus scoparius*), coast sagebrush (*Artemisia californica*), sea-cliff buckwheat (*Eriogonum*

parvifolium), black sage (*Salvia mellifera*), and California coffee berry (*Rhamnus californica*). Nesting cover is ample, with deerweed and croton (*Croton californicus*) forming matted clumps.

Roosting trees are furnished by willows which grow naturally along sloughs and around the edges of the lakes, and by acacias planted by the railroad company and the club. Annual grasses and weeds are sparse and their green period considerably shortened due to the dry, sandy character of the soil. Prime forage species such as filaree, bur clover, and the annual clovers, which are the staple quail foods in other parts of the State, are virtually absent at Dune Lakes. Seeds for quail are furnished by such species as miner's lettuce (*Montia perfoliata*) and buckthorn weed (*Amsinckia douglasiana*), which are considered inferior quail foods at best.

Rodents were numerous while the investigation was in progress; meadow mice, white-footed mice, and kangaroo rats formed the bulk of the population. Numbers of seed-eating birds, such as golden-crowned sparrows and white-crowned sparrows, were large during the period of our study. Brush rabbits (*Sylvilagus bachmani*) were abundant; in 1941, their numbers were extremely high. Early morning counts of up to 100 per one-quarter-mile stretch of road were made in one particularly favorable area during that high year.

Principal mammal predators on quail and quail nests at Dune Lakes are opossum, striped skunk, spotted skunk, feral house cat, and weasel. Raccoons, bobcats, and coyotes are taken in limited numbers. Although ground squirrels are present only on areas of good soil, and as such are possible predators on nests and young birds, their scarcity over most of the property suitable for quail makes them a minor factor compared with other parts of the State.

Cooper hawks and sharp-shinned hawks, marsh hawks, pigeon hawks, red-tailed hawks, barn owls, and horned owls are the principal raptors. Occasional duck hawks are seen, and rarely a roadrunner is encountered. Gopher snakes are common and considered to be a serious predator on quail nests.

The Dune Lakes Club Quail Management Program

The active part of the quail management program conducted by the club owners may be summarized under five headings: introduction of wild-trapped quail, artificial feeding, predator control, food and cover plant improvements, and addition to the water supply. The extent of these programs is considered below.

Introduction of Quail

From time to time during the quail management program, quail were introduced from various sources to bolster the number of native quail on the club. The only definite records prior to 1940 that we were able to uncover were a release of 186 wild-trapped quail from Santa Barbara County in the fall of 1937, a release of 350 game-breeder-reared birds in 1939, and 50 such hand-reared birds in 1940. Several hundred quail were released by the Division of Fish and Game in 1941 and 1942 in order to check the efficacy of such introductions. The results of these introductions will be discussed later.

Artificial Feeding

A unique feature of the Dune Lakes quail management program was the practice of scattering grain on the feeding areas of the various coveys. Steel-cut yellow corn was the commonest grain employed, although whole wheat was scattered to a lesser extent. The amount of feed so used varied from year to year and season to season, but observed limits ranged from six to 12 sacks per week. During the nesting season, from April to July, feeding was cut to the minimum; in the late summer the amount was gradually increased until by September, up to 12 sacks per week were scattered. The usual yearly quota was 500 sacks costing approximately $1,000 at that time.

Feeding was ordinarily done three times per week, Mondays, Wednesdays, and Fridays, and the amount of feed used was gauged to some extent by the use by quail and quail competitors.

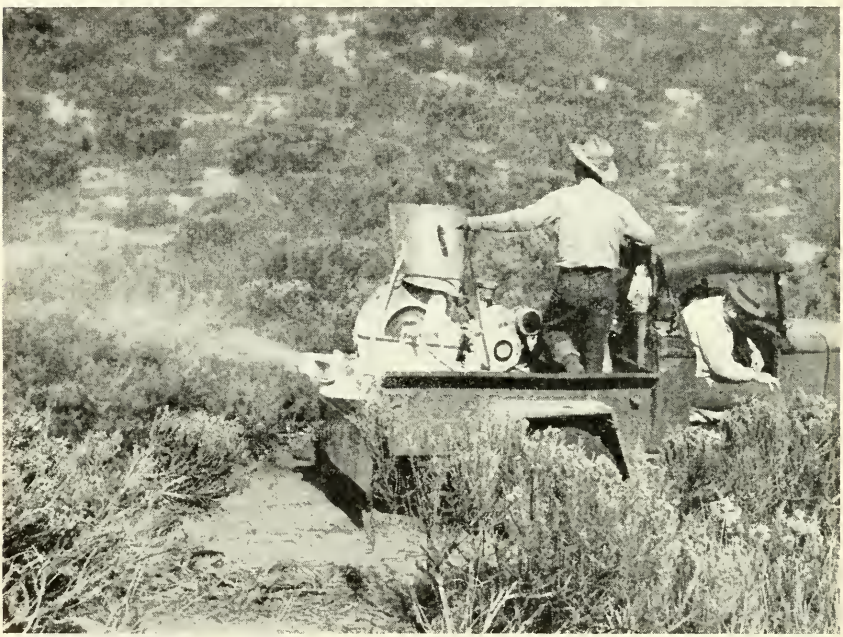

Fig. 53. Feeding quail at Dune Lakes. Feed is scattered along predetermined routes by means of this blower device mounted in the bed of a pickup truck. The low, moderately dense brush apparent in the picture is typical of the quail area.

During the first years of such quail feeding the grain was scattered from horseback. Later, feeding was done with the aid of an ingenious blower device mounted in the bed of a pickup truck (Fig. 53). This consisted of a one-sack capacity hopper which fed the grain to a blower powered by a small gasoline engine. The grain could be blown to the right or left of the truck by turning a deflector in the outlet tube, and was scattered in a band roughly 15 feet wide along the side of the road. Regular feeding routes were traversed by the pickup and the grain was scattered on predetermined strips. The location of the feeding routes

was changed from season to season to draw the quail into areas of easier hunter access. Our evaluation of this whole artificial feeding program will be discussed later.

Predator Control

Another important feature of quail and duck management was the control of predators. This control was very intensive and included virtually every possible species of mammal, bird, and reptile capable of taking quail. White-tailed kites and ospreys were the only raptors appearing over the area that were granted immunity in the early part of the program.

Table 1 is a monthly tabulation of the predator kill for 1939 and 1940 furnished by the club. It will be noted in this table that no specific designation is given to hawks or owls. Our observations in 1941 and 1942 indicate that the hawks taken were principally Cooper hawks, red-tailed hawks, and sharp-shinned hawks in that order. Small numbers of marsh hawks, pigeon hawks, and sparrow hawks were also killed. Prior to our studies, the principal owls taken were barn owls and horned owls. Pole traps, .22 rifles, and shotguns were employed in the raptor campaign, while most of the mammal predators were taken by steel traps. Weasels and rodents were taken by means of a long box (1′ x 1′ x 10′) containing about eight No. 1 steel traps. Holes, two inches in diameter were bored in the sides of the boxes and grain bait was placed inside. The rodents would enter to get grain, and the weasels and an occasional skunk or small opossum would go in to get the trapped rodents.

In addition to the predators listed in Table 1, more than 2,000 rodents (chiefly wood rats, domestic rats, various species of mice, kangaroo rats, and ground squirrels) were caught each year mainly in the weasel trap described above.

More than 100 snakes were killed annually; the total was composed largely of garter snakes, with gopher snakes making up most of the balance.

It will be noted that the mammal predator take slacked off in October, November, and December. This was due largely to the fact that during the shooting season no trap lines were maintained.

From 1941 to 1943, stomachs of all predators killed and retrieved were sent to the Food Habits Laboratory of the Division of Fish and Game. The results of the analyses of some of these stomachs will be found later in the paper.

Cover and Food Plant Improvements

From time to time during the course of the quail program, attempts were made by the club owners to establish better cover and feed conditions on the property. Cover plants which were introduced included species of *Acacia, Eucalyptus, Cytisus* (Scotch broom), and *Vitis* (wild grape). The poor soil conditions and competition with rodents, rabbits, and the native chaparral made the introduction of new cover species particularly difficult at Dune Lakes. All new plantings were protected from rabbit browsing with chicken wire guards. Of the species planted, the acacias showed the most promise; one excellent stand of quail roosts had been developed by use of these trees. The eucalyptus was planted as a wind-

TABLE 1

Dune Lakes Club 1939, 1940

Recorded Kill of Quail Predators

	1939													1940											
	January	February	March	April	May	June	July	August	September	October	November	December	Total	January	February	March	April	May	June	July	August	September	October	November	December	Total
Hawks[1]	29	22	20	8	3	12	11	8	47	123	54	63	400	70	31	23	9	3	6	19	27	31	102	62	32	415
Owls[2]	12	7		2		2		1	3	37	14	10	88	21	13			1	1		2	25	38	21	7	129
Roadrunner	2		2					1					5	1	3						2					6
California Jay	4							4					8					5								5
Sub-total, birds													501													555
Weasel		3	3	7		4	3	1	2				23				9	23	9	9	4	2				56
Skunks	5							4		3			12			1				1	3					5
Badger							1	1					2													0
Raccoon		2											2	3	1										1	5
Grey fox	2	1							1				4	4	1											5
Coyote	3		1			2	1	2					9	3				6					1			10
House cat	3	1				7	9	1	1	2			24	1	2	1	2	2	4	6	1			2	4	25
Bobcat	2						2	2				1	7	1											1	2
Oppossum	9	4	1			12	33	5	4	4		1	73	11					2	5	9	2	7		1	37
Subtotal, mammals													156													145
Totals													657													700

[1] Hawks as reported included mainly Cooper hawks, sharp-shinned hawks, and red-tailed hawks.
[2] Owls as reported included mainly horned owls and barn owls.

break to stabilize the active dunes. The smaller shrubs such as Scotch broom have not succeeded in establishing much cover; however, the need for more such shrubby species is very much in question in view of the existing extensive brushy cover on the quail areas.

European beach grass (*Ammophila arenaria*) was planted sometime in the past presumably by the Southern Pacific Railroad in order to stabilize the dunes which were encroaching on their right-of-way. This grass has spread on the southern part of the club's property (Covey A area) and has succeeded in forming excellent escape cover for quail.

Several attempts have been made to plant small grains for feed on two relatively level, small fields in the brush area. Milo and several species of millet were used. One planting of proso or Siberian millet was made under our observation. The planting resulted in but little seed and the net benefit to quail was practically nil. The dry, sandy nature of the soil makes the cultivation of such food plants impractical on this area.

From 1928 to 1941, grazing was not permitted on the club property. This allowed brushy cover to accumulate and also kept the dunes in check. This exclusion of cattle was without doubt a factor in the increase of quail. A similar area several miles to the south had the same species of brush, but the cover afforded was less than at Dune Lakes due to trampling and browsing.

Artificial Watering

Although natural watering places were far more abundant than in quail range generally, one well was driven to supply water for one covey whose range in the summer was several hundred yards from the nearest lake.

Quail Populations and Quail Harvest

That the management methods employed were successful in building up quail populations at Dune Lakes was evident beyond question. After our first visit to the club in 1940, the following notes were made.

"At present the quail population on the area is estimated by Mr. Haddox (caretaker) and Mr. Barker, who is now managing the quail, at between 3,000 and 4,000 birds. I (Glading) would be the last one to question their figures since it is practically impossible to get a reliable count of the quail due to their density and the rather even character of the brush. Suffice to say that there is a tremendous population, and that the annual take, plus the supposed crippling loss, places the population density at an extremely high level."

In the fall of 1941, when intensive quail trapping was being done in connection with population and disease studies, counts and estimates were made of the several coveys on the area. At this time, Mr. Barker again estimated more than 3,000 birds and independent estimates by the three authors varied from 2,125 to 2,445 quail prior to the 1941 open season. A Lincoln index census (see below) conducted that fall gave a figure of 2,171 quail for the area.

Table 2 will reveal that in 1941 the estimate of more than 2,000 and the Lincoln index result of 2,171 were fairly reliable in view of the fact

that a yield of 598 birds in the bag plus an observed cripple loss of 386 (total hunting season kill = 984) was possible.

TABLE 2

Dune Lakes Club 1935-1943

Annual Bag of Valley Quail

(Total area available for quail, 450 acres)

Year	Number of quail in the bag	Estimated additional cripple loss (60%)[1]	Estimated total take
1935	249	149	398
1936	391	235	626
1937	214	128	342
1938	377	226	603
1939	465	279	744
1940	535	321	856
1941	598	359	957
1942[2]	166	100	266
1943[2]	120	72	192

[1] The estimated crippling loss of 60 per cent was based on observations of the hunt in 1940 and 1941. In 1941, an actual count of 386 unrecovered cripples was made by observers following each hunting party.
[2] War years; hunting effort was extremely light.

The observed crippling loss of 386 mentioned above was an actual count by Division of Fish and Game employees or the club's game managers, who accompanied each hunter in the field in the 1941 hunt. A limited similar check in 1940 gave a like figure of an added approximate 60 per cent cripple loss.

In 1942 and 1943, the population of quail (see below) was considerably less due to loss of manpower for management. The bag in these years was even more affected by war conditions since the hunting effort was but a fraction of former years.

Cost of Management

While no exact figures on the cost of management were available to us, a rough estimate was obtained by observation of the labor, equipment, and materials used. Following is a rough estimate of costs for the management during 1941.

Labor—one and one-half man-years	$2,250
Feed	1,000
Ammunition and traps	50
Gasoline, oil, tires, car repairs	100
	$3,400

The above estimates do not include original costs of automotive and feeding equipment, taxes, interest on the property, or utilities, and hence must be considered an absolute minimum. Thus, the cost for the 598 birds taken in 1941 was at least $5.68 per bird.

While the duck hunting undoubtedly benefited by some of the above expenditure, there was yet another full-time employee, part of whose endeavors were devoted to game management; hence, the above estimates are a minimum for quail management as practiced in 1941 by the club.

Analysis of the Methods and Results of the Quail Management

Census Methods

In 1941 and 1942, the population of quail was determined by two methods: direct counts and estimates, and Lincoln index counts.

In 1941, familiarity with the coveys gained through three months of intensive quail trapping gave us a fair idea of the numbers of birds in each group. It must be admitted that this direct count is not absolute, since the size of some coveys and the lack of open feeding areas made exact counts impossible. Estimates were gained on the larger coveys mainly by flush counts as the birds flew from feeding strips. Table 3 gives the estimates of the authors for the high year.

TABLE 3

Estimated Numbers of Birds in the Various Coveys at Dune Lakes, November, 1941

Observer	Covery designation								Tota
	A	B	C	D	E	F	G	H	
1	300	450	250	375	525	75	320	150	2,445
2	250	270	300	300	450	85	320	175	2,150
3	200	400	300	300	400	75	300	150	2,125
Average	250	373	283	328	458	78	313	158	2,240

In the fall of 1942, an estimate of 1,200 to 1,400 birds was made by Glading and Ross in November prior to the hunting season. Of the total, 900 to 1,000 were estimated to be in the B, C, D, and E coveys to which hunting was confined that season.

Lincoln Index Census

In connection with the annual quail hunt in 1941 and again in 1942, Lincoln index counts of the quail were carried out. In this type of census, a number of birds are marked prior to a subsequent hunt or retrapping. Then, by using the ratio of marked birds to unmarked birds later collected, it is theoretically possible to calculate the population that existed during the marking period. The formula used in these calculations is $\frac{M \cdot T}{R} = X$, where M is the number of quail marked, R is the number of marked quail appearing in the bag, T is the number of quail bagged, and X is the calculated total number of quail in the population.

The chief difficulty with this type of census lies in getting an even distribution of marked individuals throughout the area to be censused. In order for the final results to be representative of the area as a whole, it is necessary that the number of marked individuals be in a uniform ratio to the unmarked individuals on the various sub-areas.

An attempt to meet this requirement was made in 1941 by trapping and retrapping, comparing the catch for each covey area during four prehunting season quail trapping periods. Thus, separate Lincoln index censuses were run, comparing the second, third, and fourth trapping

periods with the first, and with each other for *individual* coveys. Thereby, an index of the relative sizes of the coveys was obtained, even though the absolute sizes of coveys may not have been known.

The relative sizes obtained by the trapping and retrapping Lincoln index census were weighted and averaged with similarly weighted relative sizes of coveys as estimated in Table 3. The average relative size of each covey thus obtained was used as a basis for the release of sufficient marked quail to even up the number of marked individuals throughout the area.

FIG. 54. Baiting trap with steel-cut corn for quail to be banded and released as part of our study of the characteristics of the Dune Lakes quail population.

In the four trapping periods, 506 individual quail were marked and released. To this total, 265 introduced birds were added to bring the marked birds in each covey to the desired number. This made a total of 771 marked quail theoretically on the property at the start of hunting in 1941.

Of the total of 594 quail killed in the hunt and examined by us, 188 were banded; substituting in the above formula $\frac{M \bullet T}{R} = X$, $\frac{771 \times 594}{188}$ $= 2436$. Subtracting the 265 introduced birds from this, gives a figure of 2,171 native birds in the Lincoln index census in 1941.

A similar check was made in connection with the 1942 hunt. The Lincoln index figure for this year in these four coveys was 1081. In 1942, however, since the hunting was limited to Coveys B, C, D, and E, the Lincoln index census was confined to that area.

Old-Young Ratio Counts

Some index of the nesting success and the general condition of the quail population was obtained by examining birds killed and thus obtain-

ing the ratio of old birds (more than one year of age) to young birds (hatched in preceding summer—less than one year of age). The primary wing coverts of the old quail are a plain grey, while those of the young are spotted buff and tan.

In 1940, 498 birds taken in the hunt and examined for age characters showed a ratio of 365 young to 100 adults. In 1941, 518 native birds examined gave a ratio of 252 young to 100 adults. The figure in 1942 among 166 birds bagged was 141 young to 100 adults.

Similar old-young ratio counts were made in connection with the quail trapping conducted in 1941 and 1942. These ratios are too detailed to give completely here, but those taken just prior to the hunting seasons checked well with the above figures. Preseason trapping revealed that a gradual decline in the number of young was apparent from late July until the start of the hunting season, November 15.

Nesting Studies

As a further check on the population, and on factors affecting it, a detailed study of quail nesting was conducted in the summers of 1941 and 1942. A summary of the fate of these nests will be found in Table 4. It will be noted that the nesting success in 1941, when 19 of a total of 48 nests (39.6 per cent) were successful, was much better than in 1942, when 21 of 114 nests (18.4 per cent) hatched. This lessened percentage of success presaged the lowered population and poor old-young ratio exhibited in the fall of 1942.

TABLE 4

A Summary of the Fates of Valley Quail Nests at Dune Lakes, 1941-1942

	1941		1942	
	Number	Per cent	Number	Per cent
Successful	19	39.6	21	[1]18.4
Abandoned	12	25.0	36	31.6
Neatly robbed (no remains of eggs)	5	10.4	11	9.7
Roughly destroyed (eggs broken and eaten at nest)	9	18.8	40	[1]35.1
Hen killed (remains of her near nest)	2	4.2	6	5.3
Other (nest destroyed by grass fire)	1	2.1		
Totals	48	100.0	114	100.0

[1] The lowered nesting success and the increased predation rate in 1942 is a possible result of the lowered intensity of predator control in 1942.

In Table 4, nests listed as abandoned were largely of two types; those with few eggs which were abandoned mainly because of some disturbance frightening away the hen, and those having large numbers of eggs laid by two or more hens. The percentage of the latter type of abandonment was high at Dune Lakes presumably because of the high population density. Neither type of abandonment is considered serious, since hens will in most cases continue laying in another nest after abandoning the first.

Nests listed as neatly robbed were mainly destroyed by gopher snakes and king snakes. A few actual observations were made of gopher snakes in the act of robbing quail nests. Ground squirrels rob nests in the same fashion as do the snakes. However, since the distribution of squirrels is

limited, they are not considered to be a major factor in nest destruction at the Dune Lakes Club.

Those nests listed as "roughly destroyed" were broken up by mammal predators such as skunks, house cats, opossums, etc. This type of predation prevailed on the nests under study. Except for skunks, which have a characteristic manner of sucking the eggs, destruction by other types of mammal predators is hard to ascertain in every case.

In a few nests each year the hen had been killed but the eggs were left undisturbed. Much of this type of predation is hard to interpret, but some could be attributed to raptorial birds.

In 1941, 28 nests that reached the stage of incubation had an average clutch of 17.3 eggs; while in 1942, 35 incubated nests had an average clutch of 15.4 eggs. The number of young in the 19 hatched nests in 1941 was 16.4; in 1942, the average brood size was 13.9.

Predator Studies

Studies of the food habits of nesting raptors were made by the "cage-nest" method. A complete report of the study as far as barn owls and marsh hawks are concerned will be found in Selleck and Glading, 1943.

These studies revealed that the barn owl's diet, even in this area of extremely high quail density, was more than 90 per cent rodents, and that but a fraction of 1 per cent of all food items taken were quail. Faced with this evidence, the operators of the club dropped the barn owl from their predator list and discontinued pole-trapping since barn owls were the principal species taken by that method of control.

The marsh hawk, on the other hand, preyed quite freely on fledgling quail during the nesting season. At marsh hawk nests located in the heart of the quail concentration, more than 20 per cent of all items brought in were young valley quail.

Similar techniques were employed to study the food habits of two pairs of Cooper hawks nesting near the club. These hawks ranged only partly over the club's territory, and, hence, the proportion of quail in the diet is probably lower than would be a Cooper hawk's diet on the club proper. Of a total of 64 items brought into these nests, 21 (32.8 per cent) were quail.

Stomachs of all predators taken and retrived were saved for stomach analyses. These were turned over to the Food Habits Laboratory of the Division of Fish and Game for analysis. A summary of a part of these will be found in Table 5. Since the entire personnel of the laboratory is now in the armed forces the completion of the remainder of the stomach examination is postponed until after the war.

While Table 5 represents but a part of the predators taken during our study, it is indicative of the food habits of some of the more common ones. Of 17 species of predators represented in the analyses, five, the Cooper hawk, sharp-shinned hawk, marsh hawk, coyote, and bobcat, had quail in their stomachs. The size of the sample for most species is too small to draw accurate conclusions. However, additional field observations of predation by raptors indicate that the Cooper hawk, sharp-shinned hawk, and marsh hawk certainly belong on the predator control list. Other observations at the club indicate that the red-tailed hawk, pigeon hawk, and horned owl prey on quail locally and possibly should be included in the control program.

TABLE 5

Partial Summary of Stomach Analyses of Predators Taken at Dune Lakes, July to December, 1941

Predator	Number of stomachs examined	Number of stomachs empty	Game found in stomachs	Other animals found in stomachs
Cooper Hawk	25	8	3 quail, 7 brush rabbits	5 passerine birds, 4 rodents, 1 insect
Sharp-shinned Hawk	6	3	2 quail	1 passerine bird, 1 insect
Marsh Hawk	6	2	2 young quail, 2 brush rabbits	1 passerine bird, 2 lizards, insects
Sparrow Hawk	2	-		Insects
Pigeon Hawk	6	1		5 passerine birds, insects
Red-tailed Hawk	13	2	2 rabbits, 2 ducks, 2 coots	1 passerine bird, many insects
Red-bellied Hawk	2	-	1 coot	1 garter snake, 1 insect
Ferruginous Rough-legged Hawk	1	1		
Horned Owl	5	-		4 mice, many insects
Coyote	6	2	1 quail, 3 brush rabbits, 1 chicken	1 passerine bird, 1 ground squirrel, 1 woodrat, 1 bobcat, 1 dog, 1 oppossum, insects
Bobcat	5	-	1 quail, 5 brush rabbits, 2 ducks	3 kangaroo rats, 1 woodrat
House Cat	5	4	1 brush rabbit	
Raccoon	2	-	1 brush rabbit, 1 coot	1 woodrat, 1 crayfish
Weasel	6	2	2 brush rabbits	2 ground squirrels, 3 passerine birds
Spotted Skunk	4	2	1 brush rabbit	1 passerine bird
Striped Skunk	2	1	1 coot	Insects
Opossum	10	-	2 brush rabbits, 3 ducks, 1 coot	1 passerine bird, 1 grey squirrel, 1 muskrat, 4 small rodents, 1 garter snake, 1 lizard, 1 salamander, 1 snail, 3 crayfish, insects

The most serious depredation by mammal predators, nest robbing, is not evident in Table 5, due to the season of year of stomach collections (quail nesting is mostly over in July when the present series of stomach collections started) and to the easy digestibility of egg material eaten. In most cases, mammals merely lick out the insides of eggs and ingest little or no shells. The soft parts of the eggs and small bits of shell are easily digested or confused with stomach juices; hence, stomach analyses are not reliable indicators of an animal's importance as a nest predator.

Food Habits of the Dune Lakes Quail

Quail stomachs were taken from accidentally killed quail at all seasons of the year, in addition to crops and stomachs taken from birds killed in the annual hunts. Many of these are in the Food Habits Laboratory collection and await analysis after the war.

Visual evaluation was given to all crops collected, however, and it is safe to say that in the heavy concentration area (Coveys B, C, D, and E), where the management and hunting was most intense more than 90 per cent of the food of the quail was steel-cut yellow corn.

This was true at all seasons of the year, even at the start of green growth in the fall, when quail usually make a sharp shift from seeds to greens. Hence, it appears that the quail, through habit or necessity, had become almost entirely dependent on the artificial feeding program.

Check Area

While no strictly comparable area was at hand with which to check the Dune Lakes results, some idea of the success of the quail management program was gained by examining another dune brush area several miles to the south (Jack Lake area). The Jack Lake area had the same general aspects of topography and vegetation as were present at Dune Lakes; water was not as abundant, but adequate for quail. Grazing on the Jack Lake area had destroyed some of the cover value of the brush; however, enough cover still remained to support a sizeable quail population if it had been present. Natural feed conditions were poor as at Dune Lakes.

One small covey (25-50) of quail was present in the area of some several hundred acres. Winter and summer comparative counts of raptors and passerine birds revealed that in the summer breeding season the populations of these two groups were roughly similar at Jack Lake and Dune Lakes. In the winter, however, populations of both raptors and passerines were many times higher at Dune Lakes than at Jack Lake.

Introductions of Quail

Prior to the hunting seasons of 1941 and 1942, numbers of introduced birds were added to the population of native quail to aid in the Lincoln index census counts. Some information on the viability and permanent effect of these introductions on the native population may be gained by data collected on the 1942 release, when both wild-trapped and hand-reared birds were used. Table 6 gives a summary of the returns of these birds in the 1943 hunt, slightly more than one year after the introductions were made. It will be noted that 7.7 per cent of the native birds banded in the fall of 1941 were present in the 1942 bag, while only 1.7 per cent of the wild-trapped birds and none of the hand-reared birds appeared

in the 1942 bag. It was noted that in the 1941 hunt, none of the 350 hand-reared quail released in 1939 or the 50 released in 1940 appeared in the bag.

TABLE 6

Returns of Native and Introduced Birds, Dune Lakes Club, 1942-43

These birds were released in the fall and winter of 1942 and shot in the hunting season of 1943, one year later

	Native quail	Wild trapped introduced quail	Game farm introduced quail
Number banded and released, 1942	312	59	96
Number shot, 1943	24	1	0
Percentage of 1942 released shot 1943	7.7%	1.7%	0.0

Returns from the *same* hunting season as the year of release indicate that introduced birds are slightly more prone to be killed than are natives. Thus, in 1941, of 265 introduced birds released prior to the hunt, 75 or 28 per cent were bagged, while of 506 native birds banded prior to the hunt, 113 or 22 per cent were shot.

In 1941, records were kept of the movement of both native and introduced quail. Results given in Table 7 indicate that the introduced birds are more prone to move about than are natives.

TABLE 7

Movements of Native Versus Introduced Quail at Dune Lakes, 1941

Banded native and introduced birds were released prior to the hunting season. Records were kept of the covey of release and the covey from which these birds were killed

	Native, number	Quail, per cent	Introduced, number	Quail per cent
Remained in covey of release	77	71.3	41	54.7
Moved to adjacent covey	30	27.8	31	41.3
Moved to distant covey	1	0.9	3	4.0
Total sample	108		75	

Thus, it is indicated that immediately after release, introduced birds tend to move away from the point of release faster than do natives and that they are slightly more prone to be taken by shooting. However, one year after release, the numbers of these introduced birds that remain on the area and survive is so low that they do not form an appreciable part of the shootable population.

Studies of Valley Quail Diseases

In cooperation with Dr. Carlton M. Herman, Parasitologist of the Bureau of Game Conservation of the Division of Fish and Game, extensive collections of blood, hearts, and fecal material were made from trapped and shot quail at Dune Lakes. An account of various aspects

of these studies concerning coccidiosis will be found in Herman and Chattin, 1943. Results of other phases of the disease work are in preparation. To date, however, no indication is present that the concentration of quail that existed in 1941 at Dune Lakes was more infested with parasites than were quail generally throughout California.

An Evaluation of the Dune Lakes Quail Program

As a result of our observations and experiences at Dune Lakes, we give the following appraisal of the methods used to increase quail.

The area itself is a special case; it is not typical of quail range generally for the following reasons: (1) It is naturally deficient in quail foods. (2) It probably has an abnormally high predator population due to its location along the coast migration route of hawks, and to the fall concentration of waterfowl which attracts various predators. (3) The area is better watered than is most quail range.

There is no question about the fact that the management practiced resulted in a super-abundance of quail. Our estimated costs of the program are presented here as a matter of record only and need not be reckoned as the costs of quail management under other conditions. Management on more favored lands may be done at much less cost per bird in the bag and still give gratifying returns.

The feeding was probably necessary under the poor forage conditions existing at the club. Such a high concentration of birds could not have existed locally without some such supplement. Stomachs of quail taken during all seasons of the year show that almost all of their diet was steel-cut corn. In view of this, it probably would have been better if a more balanced diet, such as a commercial chick scratch, were fed instead of the yellow corn. There was some evidence leading to the belief that the corn diet was deficient in vitamins of the B complex, since "bilateral graying" was observed on the feathers of some of the late-hatching young birds.

Feeding by itself probably did not result in an increase in the quail. This is borne out by other observations at Kettleman Hills, California (Glading, Enderlin and Hjersman, 1945). Rather, it was necessary to feed in order to supplement the low feed potentialities of the local area and to maintain the abnormally high quail population which could not have existed without such supplement.

It is our belief that the intensive local predator control such as was practiced in the years up to 1941 was largely responsible for the high population of quail. This is borne out in part by the fact that in 1942, when predator control was comparatively lax due to the loss of manpower and the illness of the remaining employee, the population slumped badly, even though feeding continued at roughly the same rate. Unpublished studies of the Cholame Experimental Area (Glading and Ross, ms.) reveal that such intensive local predator control can result in considerable increase in quail. That the predator control practiced was too all-encompassing as to species taken is apparent. As a result of our early studies, some of the predators, such as the barn owl, were voluntarily removed from the predator list by the club and pole trapping was discontinued. Control of other species, including the sparrow hawk and the various buteo hawks, was relaxed at our suggestion. These latter were only taken when they appeared to be harassing quail.

Intensive control of a few species of raptors, such as the Cooper hawk, sharp-shinned hawk, marsh hawk, and possibly the pigeon hawk, red-tailed hawk, and horned owl, and trapping or control of the principal predators on quail nests, such as skunks, opossums, house cats, bobcats, gopher snakes, and possibly raccoons and coyotes, together with rodent control, would have probably accomplished the same effect with less labor.

The cover improvement program had not much effect as far as quail were concerned except in the instance of one series of roosts developed from acacia plantings. The one attempt at planting of food observed by us was negligible in its effect on quail. The one new watering place added had some small value in increasing the value of quail habitat, but can not be considered of importance in the total increase of population. Exclusion of grazing probably had more effect on the native cover and feed than all attempts at planting, and must be considered an important part of the management program. However, lest we be quoted as recommending grazing exclusion as a general management procedure over all valley quail lands, we feel that it was justified and gave results at Dune Lakes because of the character of the feed and brush as influenced by the dune conditions. Over quail range generally, however, moderate grazing is more to the advantage of quail than no grazing, provided proper precautions are taken to safeguard cover.

While the early introduction of wild-trapped and hand-reared quail might possibly have helped in building the population in its initial growth, our observations indicate that such additions after the population was at its observed high peak were valueless.

Summary

An extremely high valley quail population (up to 4.8 birds per acre in late autumn) was built up by private individuals at the Dune Lakes Club by habitat management. In the years 1939 to 1941, the bag averaged more than one quail per habitable acre during the annual hunt. The chief management methods employed were artificial feeding and predator control. Planting of feed and cover, management of grazing, introduction of new birds, and supplying additional water were also practiced.

Studies were conducted on the methods employed and observations made of the habits of predators. Under conditions that existed at the club, the intensive local predator control practiced was probably largely responsible for the high quail population. Feeding of quail was necessary to maintain the high population.

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THE PACIFIC TUNAS [1]

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The California Division of Fish and Game has recently published "A Systematic Study of the Pacific Tunas," Fish Bulletin No. 60, by Godsil and Byers. This paper presents the results of a study of the anatomy of the five species of tuna which furnish the greatest proportion of California's tuna catch and which are widely distributed in the Pacific. An understanding of the relation of a fishery to the species upon which it is based requires first that those species be accurately defined. Studies of distribution of each species and of the existence of independent stocks within the different species may then be carried out.

The only comprehensive work on the systematics of the Pacific tunas was published by Kishinouye.[2] He found that separation of the various species required a careful study of their anatomy. To follow the approach laid down in his paper, a similar detailed anatomical treatment was required to compare those species supporting the California fishery with Kishinouye's descriptions. Although this work appears to be principally morphological, the great detail in which the anatomy of the Eastern Pacific tunas has been studied will form a firm foundation upon which investigations may be extended into lines more directly applicable to conservation.

The most important question was whether or not the yellowfin tuna, the skipjack and the albacore belong to the same species as those taken in Hawaiian and Japanese waters. Such has proved to be the case. It will be necessary therefore to determine by a further study of each of these species whether the stocks on this coast or within the range of the California fishermen are separate from the populations off the Hawaiian Islands and Japan.

Lack of time prevented similar studies on the bonitos, *Sarda velox* and *S. lineolata,* and on the black skipjack, *Euthynnus lineatus.* It is hoped that these forms may be investigated at some future date. These species are not reported, however, from Mid- and Western Pacific waters and their distribution does not present as great complexities as the other four. A picture of the bonito is presented here in addition to the five species discussed in Fish Bulletin 60, and sufficient information included in the key at the end of this paper to identify it.

Reports from fishermen and an observation by the Japanese scientist Kishinouye concerning the occurrence of *Parathunnus mebachi,* in the Eastern Pacific have been confirmed. This fish is similar to the yellowfin tuna, but differs from it in that the body and head are deeper, the pectoral

[1] Submitted for publication, June, 1945. Mr. Godsil is now on leave, serving in the Merchant Marine.

[2] Kishinouye, Kamakichi. "Contributions to the Comparative Study of the So-called Scombroid Fishes." Tokyo University. College of Agriculture. Journal, vol. 8, no. 3, 1923.

fins are longer and the eyes are conspicuously larger. For this reason, and because the specific name means, in Japanese, "big-eye," we suggest as a common name for this fish, the "big-eyed tuna." The name is descriptive, and is, moreover, commonly applied by fishermen to this fish. The species was first described by Kishinouye from Japanese waters. Except that it is taken occasionally at the Galapagos Islands and sometimes in the vicinity of Guadalupe Island (Mexico), nothing is known of its habitat on this coast. Kishinouye states that it is ". . . probably widely distributed in the deeper layer of the sub-tropical region of the Pacific Ocean."

The species described in this report are quite distinct and usually they are easily recognized. However there is an overlapping in the range of variation in certain distinguishing characters, and at times this fact makes difficult a positive identification of a single fish unless one is familiar with the anatomy of the tunas. For this reason, a few superficial characters are listed below which will usually serve to identify a tuna, and other characters are mentioned which will make possible a positive identification of any doubtful specimen. Comparative views of the liver and viscera are presented in Fig. 55 to illustrate the points discussed. Comparable differences exist in every organ system.

The skipjack is quite distinct and can be separated from all other local tunas by the four or five oblique, dark stripes on the silvery belly, and the absence of stripes on the blue to violet-colored back. The color tone is similar to that of the bonito (*Sarda*), but in the bonito the oblique, dark stripes are absent on the silvery belly and present on the back.

The yellowfin tuna may be confused at times with the bluefin tuna and with the big-eyed tuna. When first caught there is generally a golden-yellow, iridescent band along the side of the yellowfin, separating the blue above from the silvery-grey belly. The latter is marked with transverse white bars with irregular white dots or blotches between. The fins are tinged with yellow and the finlets are frequently if not generally a lemon yellow, edged with black. The color, however, soon fades and within an hour or less ceases to be a distinguishing character.

The character most commonly used to identify the yellowfin is the pectoral fin. This is moderately long and usually reaches past the insertion of the second dorsal fin, but it very rarely reaches the anal insertion. The yellowfin may thus be distinguished from the bluefin tuna, because in the latter the pectoral fin is short, and only exceptionally reaches the insertion of the second dorsal. Moreover, in the yellowfin tuna, the lower posterior angle of the preoperculum, and to a lesser extent the opercular assembly (gill cover) is square, where as in the bluefin it is rounded. Also, the vent in the yellowfin is elliptical or pear-shaped, but round in the bluefin. This character fails in the case of some large yellowfin, where the vent may be round. A positive identification may always be made by inspection of the liver. In the yellowfin the ventral surface of the liver is unmarked and of a uniform color, but in the bluefin it is always marked by fine, conspicuous dark striations radiating from a small central area. The means of distinguishing the yellowfin from the big-eyed tuna will be discussed under the latter species.

The albacore is characterized by its extremely long pectoral fin which invariably reaches beyond the insertion of the anal fin. The only fish

with which the albacore can normally be confused is the big-eyed tuna which also has a long pectoral fin. In the latter, however, the vent is elliptical or pear-shaped, whereas in the albacore it is round. In the event that these characters fail, the appearance of the liver is specific. In the big-eyed tuna the ventral surface of the liver is uniform in color, with short, faint striations at the margin. In the albacore the liver is conspicuously marked with dark striations radiating from a small central area as in the bluefin. As the bluefin can not be confused with the albacore, the liver therefore affords the most certain means of identification of the latter.

The bluefin tuna resembles in general the yellowfin in shape, coloration and markings but differs from it in the absence of the golden-yellow iridescent band along the side, and in the fact that the finlets, though frequently yellow, are not edged with black. From the yellowfin and the remaining tunas the bluefin is generally distinguished by its short pectoral fin which reaches as a rule the eleventh or twelfth dorsal spine, very rarely extending to the insertion of the second dorsal fin. The round vent and the rounded margins of the gill-covers in the bluefin further aid in its identification. A final and positive identification may be based upon the appearance of the liver, the ventral surface of which, as in the albacore, is invariably marked with fine, conspicuous striated blood vessels.

The big-eyed tuna is more difficult to identify positively. The coloration and markings are in general similar to those of the yellowfin, with which it is easily confused even by commercial fishermen. The most convenient identifying character is the length of the pectoral fin. In the yellowfin this reaches past the insertion of the second dorsal fin but only exceptionally to the level of the anal insertion. In both specimens of the big-eyed tuna examined, the pectoral extended well beyond the insertion of the anal fin. In this respect it resembles the albacore, from which the big-eyed tuna may generally be distinguished by its elliptical vent, in contrast with the round vent of the albacore. Other characters which separate the big-eyed tuna from both the albacore and the yellowfin are the depth of the body and the length of the head. The ratio $\frac{\text{body length}}{\text{head length}}$ varied between 3.27 and 3.62 in the albacore, between 3.35 and 4.00 in the yellowfin, whereas the two specimens of the big-eyed tuna gave values of 3.13 and 3.29. In the case of the ratio $\frac{\text{body length,}}{\text{body depth}}$ the values for the two specimens of big-eyed tuna were 3.35 and 3.53, whereas this ratio in the albacore varied between 3.61 and 4.26, and in the yellowfin between 3.50 and 4.08.

The identity of the big-eyed tuna may be settled definitely by a view of the viscera. The faint marginal striations on the liver will always distinguish the big-eyed tuna from the albacore, but as these striations in the former are not always apparent, the appearance of the liver may resemble that of the yellowfin. In such cases the spleen may be used for a positive identification. The spleen is a dark-red organ which in the yellowfin is conspicuously located ventral to the intestine, but in the big-eyed tuna it is dorsal to the intestine and therefore not seen, or at least not conspicuous, in ventral view.

A key for the identification of six species of tuna found off the California coast.

A. Pectoral fin short, rarely reaching insertion of second dorsal

a. Body marked with dark oblique stripes

b. Four or five oblique dark stripes on silvery belly_____Skipjack, *Katsuwonus pelamis.*

bb. Oblique dark stripes on back_____Bonito, *Sarda lineolata.*

aa. No dark striping on body—vent round—lower posterior angle of preoperculum rounded—ventral surface of liver striated with blood vessels_____Bluefin, *Thunnus thynnus.*

AA. Pectoral fin longer, usually reaching past insertion of second dorsal

a. Pectoral fin usually reaching past insertion of second dorsal but rarely reaching anal insertion—vent elliptical—posterior angle of preoperculum square—liver unmarked and of uniform color_____Yellowfin, *Neothunnus macropterus.*

aa. Pectoral fin reaching beyond insertion of anal fin.

b. Vent round—liver marked with dark striations_____Albacore, *Thunnus alalunga.*

bb. Vent elliptical—liver plain or marked with faint striations on margin only_____Big-eyed tuna, *Parathunnus mebachi.*

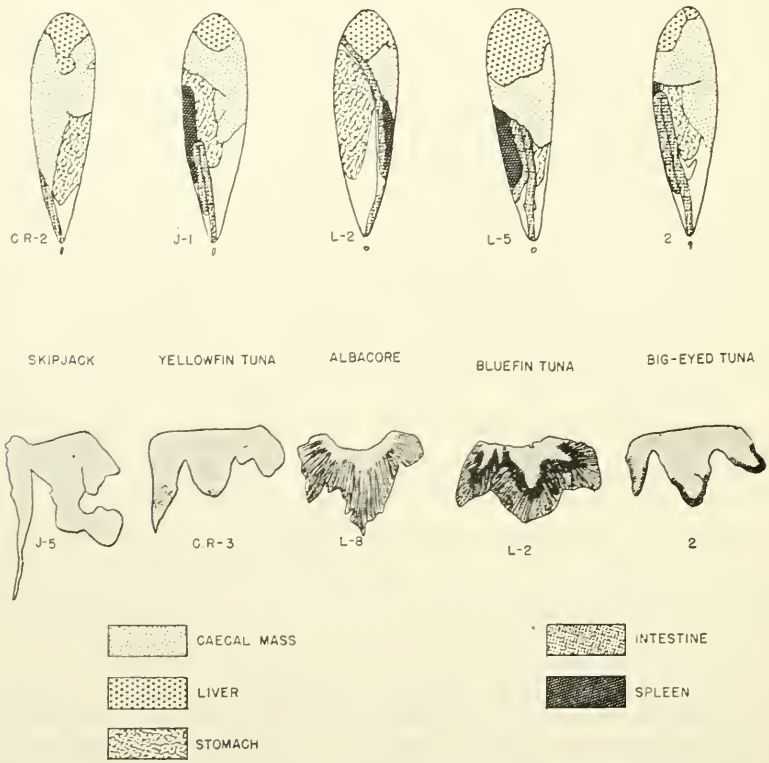

FIG. 55. Ventral view of the viscera, *in situ*, above. Ventral view of the excised liver, below.

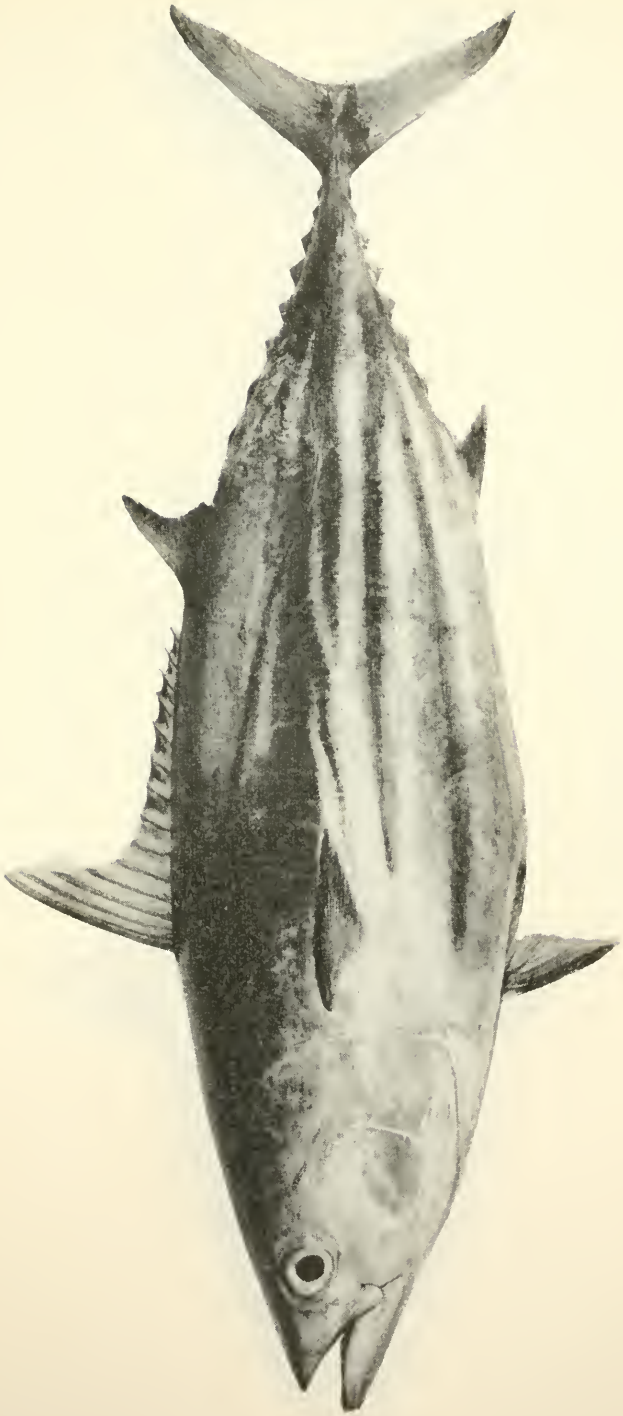

FIG. 56. Skipjack, *Katsuwonus pelamis*.

FIG. 57. Bonito, *Sarda lineolata*.

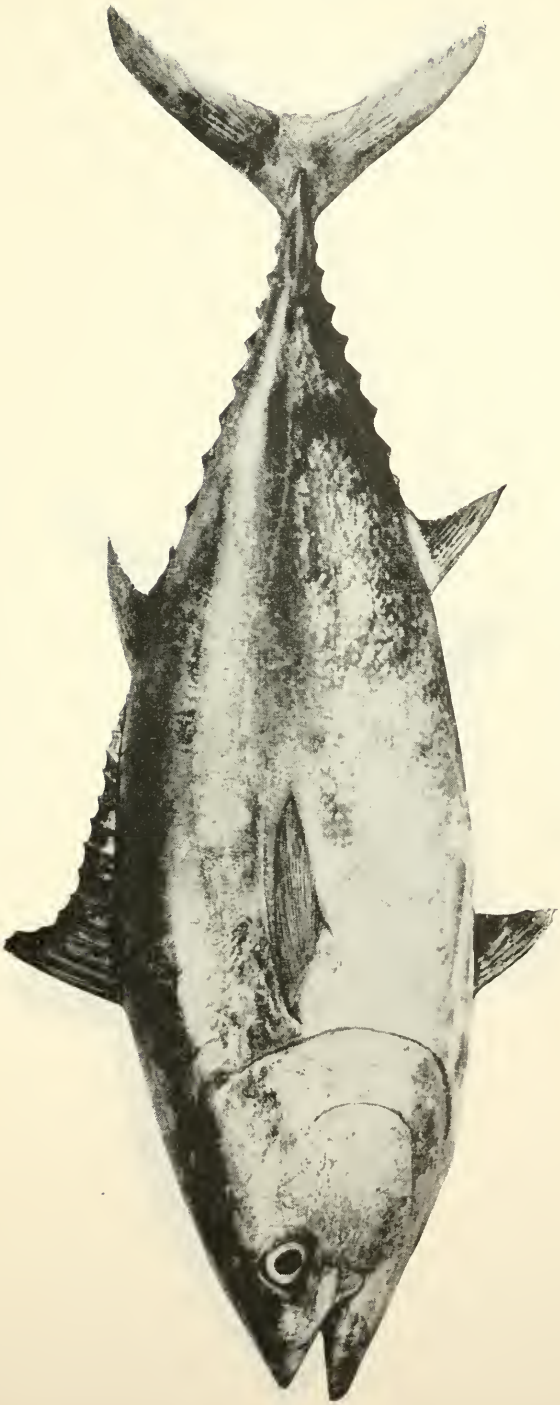

FIG. 58. Bluefin tuna, *Thunnus thynnus*.

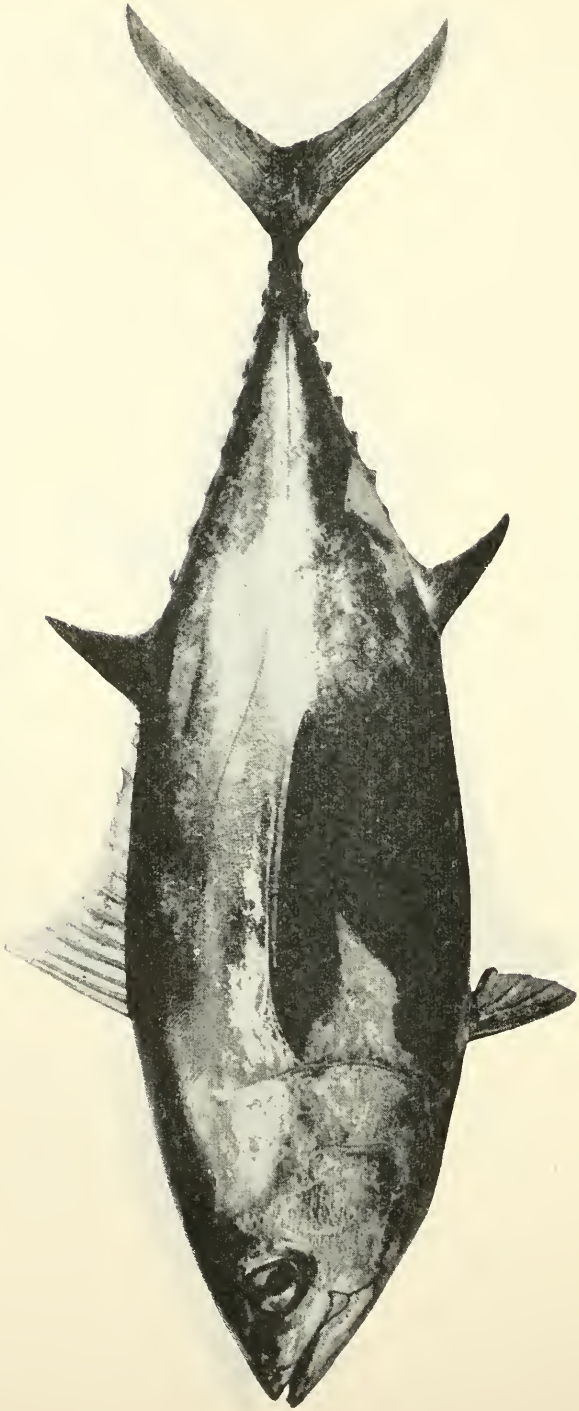

FIG. 59. Yellowfin tuna, *Neothunnus macropterus*.

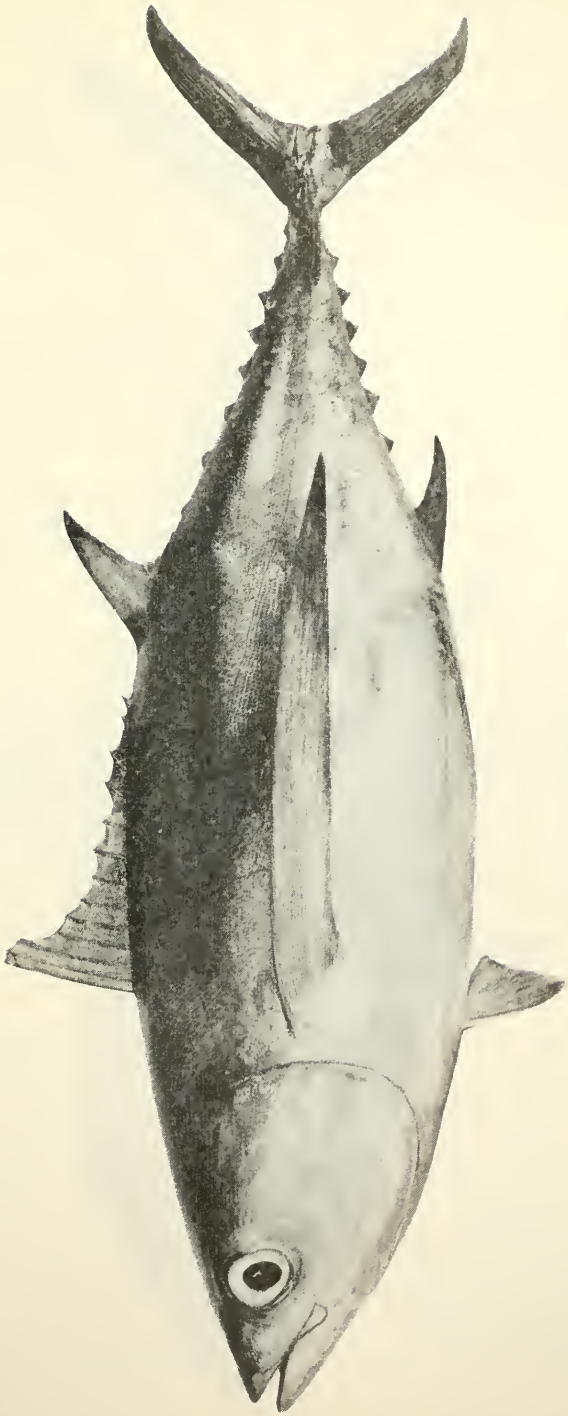

FIG. 60. Albacore, *Thunnus alalunga*.

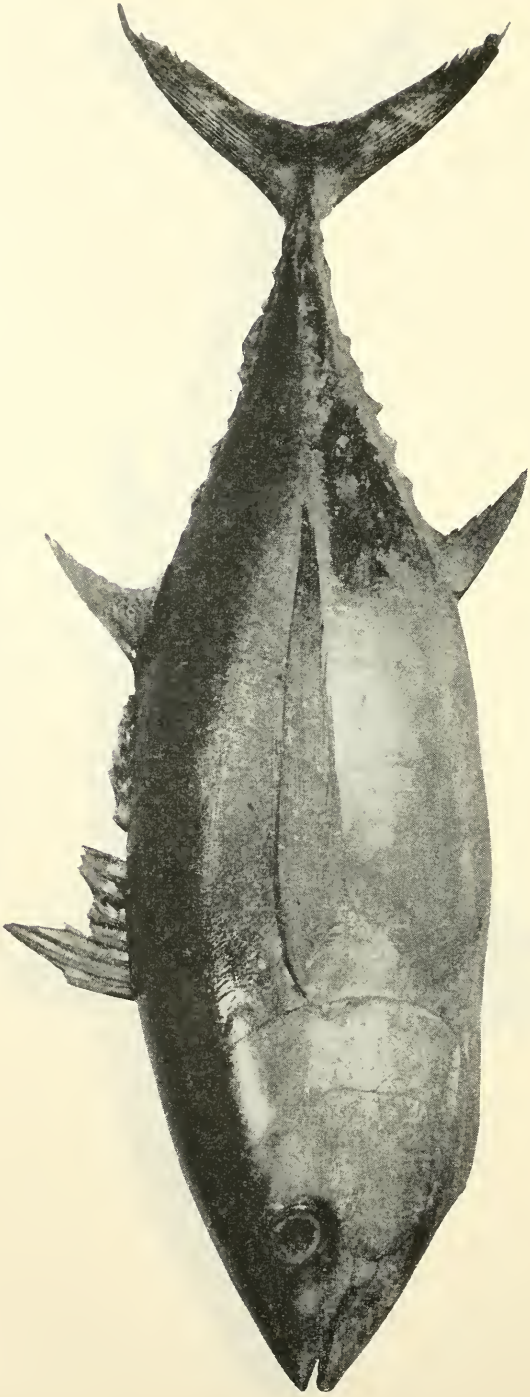

FIG. 61. Big-eyed tuna, *Parathunnus mebachi*.

CALIFORNIA SEAROBIN (*PRIONOTUS STEPHANOPHRYS*), A FISH NEW FOR THE FAUNA OF SOUTHERN CALIFORNIA [1]

By Carl L. Hubbs
Scripps Institution of Oceanography of the University of California

Fishes of the genus *Prionotus,* known as searobins, are common members of the Atlantic Coast fauna of the United States and are not rare on either side of tropical Middle America, but have very seldom been found on the Pacific Coast of the United States. In fact, only one of the several species known from waters to the southward has been recorded on valid grounds from as far north as California, and only two or three specimens seem to have been collected north of the Mexican border. It is therefore of interest to report the first taking in southern California of a specimen of this species, *Prionotus stephanophrys* Lockington (1881, pp. 529-532).

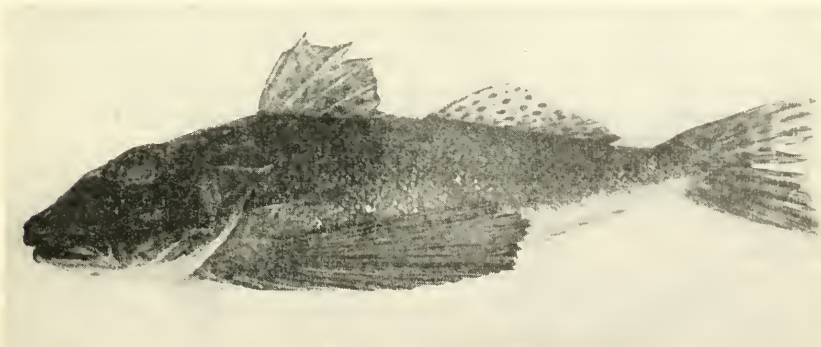

Fig. 62. California searobin, *Prionotus stephanophrys*: a 12⅛-inch specimen, the first to be recorded from Southern California. Photograph by Paul Williams.

Although the species has so seldom been collected in California, the first described or type specimen was taken in October, 1880, in a paranzella trawl "in the tolerably deep water of the region between the rocky islets known as the Farallones, the entrance of San Francisco Bay, and Point Reyes, a rocky promontory some forty miles north of San Francisco." The discription of the species by Jordan and Gilbert (1883, p. 736) and the revisionary treatment by Jordan and Hughes (1886, pp. 329 and 334) were both drawn up on the basis of Lockington's one example (No. 27048, United States National Museum). No further material appears to have been recorded until 1896, when Jordan and Evermann (p. 487) assigned to this form a range in "deep water, off San Francisco, Point Reyes, and Monterey." Presumably "San Francisco" referred to the type speci-

[1] Submitted for publication, May, 1945. Contributions from the Scripps Institution of Oceanography, New Series No. 267.

men and the Point Reyes record was probably based on a specimen (No. 2001) in the fish collection of Stanford University, but no basis has been found to validate the Monterey report.

All subsequent published records for *Prionotus stephanophrys* are for waters south of California. These records need some consideration, since they are surrounded with confusion. The first southern report was by Jordan and Evermann (1898, p. 2161) who added Lower California to the previously assigned range of the species and drew up their description from "Mr. Lockington's type, and from two others collected by the *Albatross* at Station 3041, coast of Lower California." This station was in Magdalena Bay at a depth of 27 fathoms (Townsend, 1901, p. 407), but the two specimens apparently came from *Albatross* Station 3039, just off Magdalena Bay, at a depth of 47 fathoms. According to Dr. Leonard P. Schultz of the United States National Museum, Jordan and Evermann apparently transposed the Lower California stations for two species of *Prionotus,* giving Sta. 3041 for *stephanophrys* instead of Sta. 3039, and Sta. 3039 (wrongly located "in the Gulf of California") in place of 3041 for *quiescens.* The next record for *P. stephanophrys* which I find is that of Ulrey (1929, p. 9), repeated by Cuestra Terron (1932, p. 79), for "Gulf of California," but there seems to have been no basis for this report. Some clerical error was probably involved. Later Breder (1936, pp. 39-40, fig. 13) did report *P. stephanophrys* from "Angelus" [Angeles] and San Francisquito bays on the east coast of Baja California, and also from the west coast of Mexico just north of the Guatemala border. Hiyama's figure of "*Prionotus quiescens,*" which he reports (1937, p. 56, pl. 90, fig. B) to be "common in Gulf of California," seems to represent *P. stephanophrys.*

The validity of these Mexican reports for *P. stephanophrys* are open to some doubt, and the Gulf of California records of *P. quiescens* may all belong with *P. stephanophrys.* Indeed the two nominal species may prove inseparable. Breder's identifications, cited above, were made with some hesitancy, and his figure shows several points of divergence from *P. stephanophrys,* particularly in the almost unspotted first dorsal fin.

It is obvious that a critical revision of the Pacific species of *Prionotus* is much needed. Material for such a study is now rather plentiful, in the fish collections of the New York Zoological Society, American Museum of Natural History, Bingham Oceanographical Collections, United States National Museum, Stanford University, California Academy of Sciences and the Allen Hancock Foundation of the University of Southern California.

The one previous report of a searobin from southern California was probably an error. In "A Check-list of the Fishes of Southern California and Lower California" Ulrey (1929, p. 9) indicated by symbol that *Prionotus gymnostethus* occurs in southern California. No *Prionotus,* however, is mentioned in Ulrey and Greeley's report (1938) on their southern California collections and no specimen of any Pacific species of the genus could be found in examining Ulrey's collection, now in the Allen Hancock Foundation. Nor is any *Prionotus* listed in Barnhart's book on the "Marine Fishes of Southern California" (1936). No evidence whatever could be found to substantiate the inclusion of southern California in the range of *P. gymnostethus.*

To summarize what is known of the distribution of searobins in California, it may be stated that only one species, *Prionotus stephanophrys* Lockington, has been recorded on authentic grounds from the State. Only two California specimens, both collected long ago near Point Reyes, have been located in any of the museums that might be expected to have material from the State. The one other locality record, for Monterey, has not been validated. The same species probably occurs on the outer coast of Baja California and in the Gulf of California, and perhaps in still more southerly waters, but there appears to be no valid record for the occurrence of this or of any other species of *Prionotus* in southern California.

That *Prionotus stephanophrys* does live in southern California may now be affirmed. A specimen 12⅛ inches in overall length was caught in Santa Monica Bay on October 24, 1944, 64 years after the type was trawled near San Francisco. The new specimen was taken on a hand-line by Michael Waxman four to five miles off El Segundo. According to Hydrographic Office charts this locality is at approximately Lat. 33° 53′ N., Long. 118° 30′ 30″ W. Here the depth is indicated as about 30 fathoms and the bottom as of sand and gravel. The example, a female with eggs approaching ripeness, is illustrated on Fig. 62. It is deposited in the Natural History Museum of Stanford University (No. 39788).

Like other searobins this specimen has the upper parts and sides of the head covered by an armature of bony plates ornamented with granulated ridges. These bones, however, are less roughened than in most species of *Prionotus* and the spines of the head are relatively weak. The main part of the blackish pectoral fin is a large flabby structure resembling the "wing" of the distantly related flying gurnard, to which some biologists with free imagination attribute the power of flight. Below this membranous part of the pectoral there are the three separate finger-like rays that are an outstanding feature of the family (Triglidae) in which *Prionotus* is classified.

The southern California example corresponds well with the published descriptions of *P. stephanophrys*. The main discrepancies—a smaller eye and lower ridges and shorter head spines—are attributable to a difference in size, for the new specimen is an adult and those previously described were only half-grown.

For the benefit of ichthyologists who may undertake a critical study of the characters and distribution of *Prionotus stephanophrys* and other Pacific species of the genus, there follows a detailed description of the new specimen, which is the first adult to be described. The figures in parentheses are the proportional measurements expressed in thousandths of the standard length (252 mm.).

The body is moderately robust for a gurnard, with the greatest depth (260) below the middle of the first dorsal base. The dorsal and ventral contours are nearly horizontal along most of the trunk but then converge backward to the rather slender caudal peduncle (depth, 71). The body throughout is slightly compressed, except above the end of the anal base, where it is as wide as deep (greatest width, across scapular spines, 229).

The head is long and massive (length to end of opercular membrane, 390; to end of opercular spine, 384; to occiput, 291). Then depth of the head below the occiput (230) approximates the greatest width across the preopercular spines. The dorsal contour is gently concave from the tip of the snout to a rather prominent hump in front of the eye, thence less steep and slightly convex to the front of the dorsal (the respective angles formed with the mandibular edge are 51° and 23°). As seen from

above the front of the snout is widely truncated but scarcely emarginate. Measured between the centers of radiation on the suborbitals the width of the snout (169) somewhat exceeds the depth (158) below the preocular spine. The snout length (148) enters the head length about 2.6 times. The eye (61) is contained about 2.4 times in the snout; the bony orbit (95), 1.6 times.

The interorbital is broad and nearly flat, though shallowly grooved on either side of the low rounded median ridge. Its least width (57) is a little less than the length of the eye. The edges of the interorbital are deeply concave (width across preocular bony rim, 61; between preocular spines, 78; between edges of crest posteriorly, 90). The width between the occipital spines (94) is a little greater than the distance (87) from the occiput to the dorsal origin. The least distance from the bony orbit to the preorbital edge (63) barely exceeds the length of the eye. The distance from the preopercular ridge to the tip of the opercular spine is 116 thousandths of the standard length.

The head spines are very weakly developed. The lateral margin of the snout is roughened by about 20 tuberculate spinelets directed forward. The upper anterior border of the orbit bears indistinct points at the tips of short ridges. The strongest of these points forms the scarcely differentiated preocular spine. The postocular spine has a free projection of less than 1 mm. on one side and of even less on the other side. The edge of the gentle slope in front of the postocular spine has fine, rather indistinct serrations at the ends of tuberculate ridges. Behind the postocular spines the bony margin forms a semicircular indentation and the surface of the head becomes abruptly flatter, but there is no definite transverse groove. There is a rather large bony excrescence at the anterior end of the lateral line a short distance in advance of and slightly below the weak low-lying occipital spine, which does not extend to opposite the dorsal origin.

The suborbital margin is very finely and indistinctly serrated. There is no trace of a spine at the center of radiation on the suborbital. Measured from the suture between the suborbital and the preopercle, the length of the preopercular spine (60) almost equals the length of the eye, but the spine is free for only half its length and its tip does not reach the free margin of the suboperele. The indistinct upper opercular spine is flat and far removed from the opercular margin. The outer edge of the thin opercular bone is nearly semicircular between this spine and the flattish, somewhat upturned main opercular spine, which extends slightly beyond the opercular membrane.

The mouth is rather large, as the upper jaw (163) reaches slightly beyond the vertical from the front of the orbit and measures 2.35 in the head. The proportional length of the mandible is 175. Fine villiform teeth form rather narrow bands with the following maximum widths, expressed in ten-thousandths of the standard length: premaxillary, 102; vomer, 83; palatine, 100; mandible, 91. The vomerine patch is weakly convex. The gill-rakers on the outer arch number 4 above the angle, with only one well developed, and 19 below, becoming rudimentary at about the tenth. Interpolated between the main rakers are small denticulate tubercles. There are seven branchiostegals.

Of the 10 dorsal spines the third and largest is about two-fifths as long as the head. The proportional lengths of the first four spines are: first, 123; second, 137; third, 163; fourth, 155. The others become progressively shorter to the tenth, which is largely imbedded. The front edge of the first spine is finely granulated along the basal half. The soft-rays number 12, with the first one unbranched but articulated. The anal formula is I, i, 9 (the anal formula of *Prionotus* has apparently been misinterpreted; in *P. stephanophrys*, as presumably in the other species, the first of the two unbranched rays is a true though somewhat flexible spine, whereas the second anal ray, like the first ray of the second dorsal, is a paired and articulated though unbranched soft-ray).[2] The proportional lengths of the anal rays are: spine, 42; unbranched soft-ray, 72; first branched ray, 88; fifth and longest branched ray, 98. The caudal fin, which has 12 principal rays (10 branched), is weakly lunate (length of shortest median ray, 189; of longest ray, 231). The main part of the pectoral fin has a very weakly convex posterior edge from the first to the ninth of the 13 rays, of which the first and the last are simple, the others once branched (the lengths of the rays on the right side—the left fin was injured—are as follows: first, 339; seventh and longest, 424; ninth, 420, graduating to the eleventh which is 229). The fin extends to above the base of the sixth anal ray. The tips of the free pectoral rays are scarcely swollen and these rays are graduated in length (219, 190, and 158). The pelvic fin (254) extends three-fourths the distance to the anus.

[2] The morphological and systematic aspects of fin structure in teleosts are discussed in a recent paper (Hubbs, 1944) and will be further considered in forthcoming papers.

The thin, weakly ctenoid and rather poorly imbricated scales are probably characteristic of the species. They are reduced in size on the nape, near the midline of the belly and about the isthmus, but are rather large near the center of the breast and just behind the pelvic fins. Over the pubic bone medically the scales are slightly imbricated, but just in front of each pelvic and over most of the belly they are nonimbricate. A scaleless strip extends from behind the pectoral base to just behind the pelvic base, but the main part of the breast is scaly. The head bears a few scales on the upper part of the subopercle, between the two opercular spines. There are 52 pores in the lateral line.

In formalin the body is rather sharply bicolored. The side above the upper edge of the pectoral fin is warm purplish brown with scattered blackish brown specks and small blotches, but is not barred. The lower side and the ventral surfaces are white. A trace of yellow remains on the under side of the head. Above, the head is scarcely spotted, except for obscure speckling on the upper part of the eye. Both dorsal fins and the caudal are dusky purplish with blackish purple spots. Of the numerous spots on the first dorsal the two that are most conspicuous lie, respectively, between the fourth and the fifth and between the fifth and the sixth spines, but there is no large black blotch in this area. The second dorsal bears conspicuous rounded spots, which do not quite reach the upper margin and mostly lie along the front of the rays. These spots are alignable into three or four rows and indefinitely into about two more rows. The spots on the caudal are less distinct and the submarginal ones are elongated, though not fused to form a band. On the upper lobe the spots comprise about five bars, but those on the lower lobe are much less distinct. The anal and pelvic fins are white, with some sooty color on the rays. When folded the pectoral fin is purplish black, but when spread it is dusky purplish with numerous, irregularly elongated blackish spots.

The taking of this specimen once again illustrates how incomplete is our knowledge of the fish life of the moderate depths along the coast of southern California. It is quite possible that this and some other species being discovered in these waters may prove of some commercial significance, when federal restrictions that now hold down the coastal fisheries may be lifted. It is reported that in 1943 more than 300,000 pounds of searobins were taken in the commercial fisheries of the New England and North Atlantic states.

Acknowledgments

Data regarding specimens of searobins and references to the literature have very kindly been furnished by W. I. Follett of Oakland, the indefatigable student of California fishes, and by Leonard P. Schultz and Robert R. Miller of the United States National Museum, Irene McCulloch of the Hancock Foundation of the University of Southern California, William Beebe of the New York Zoological Society, Daniel Merriman of the Bingham Oceanographical Collection, Wilbert M. Chapman of the California Academy of Sciences, and by George S. Myers, Margaret Storey and Rolf L. Bolin of Stanford University. Thanks are also due to collector, Michael Waxman, for his thoughtfulness in bringing the rare specimen to the California State Fisheries Laboratory and to Frances N. Clark of that laboratory, for the privilege of examining and reporting on the rare find.

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SOME WORM PARASITES OF DEER IN CALIFORNIA [1]

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The proper management of deer requires a knowledge of many factors which regulate population density. One of these factors is disease.

Many diseases occur in deer. As in man, the cause of the condition may be due to microorganisms, parasites, nutritional deficiencies, or general upsets in body activities. Most of these are of a complex nature and their diagnosis requires particular procedures by specialists trained to recognize symptoms and to carry out laboratory tests, microscopic examinations, etc. However, many of the worm parasites that occur in deer are of such a size and nature that no elaborate technique is necessary to discern their presence.

This paper is an attempt to describe these parasites in such a manner that the sportsman can recognize them, and, if opportunity presents itself, collect specimens for further examination. Hunters annually harvest large numbers of deer in California and some of these animals could yield much information on the prevalence of disease that would otherwise be almost unobtainable.

Very little is known of these worms in deer, as is true as well of other diseases of these animals. In the ordinary course of events comparatively few deer come to the laboratories of trained specialists for examination. While much can be learned of value from careful examination of a few species, there are many important problems that can be solved only by obtaining data on large numbers. For example, a full knowledge of the geographical distribution of the worm parasites might prove very helpful in suggesting further studies of importance. If one were to attempt an investigation entirely on his own resources it would be necessary in many cases to slaughter large numbers of animals in order to obtain factual data of statistical value.

Various methods have been attempted by game management agencies to obtain the cooperation of sportsmen in securing information necessary to govern management of wild animals. This has usually taken the form of questionnaires, sometimes voluntary on the part of the hunter, sometimes compulsory. Such procedures have yielded data which have often been of much aid in deciding regulations in regard to closed areas, bag limits, etc., and have thus contributed much to conservation of the game.

Little of this technique has been attempted in disease studies. During the past three seasons a number of hunters (particularly members of the Associated Sportsmen of California) have cooperated with the

[1] Submitted for publication, June, 1945.

laboratory of the Bureau of Game Conservation of the Division of Fish and Game by procuring blood smears of quail which they shot. While the numbers thus received are very small in comparison to the complete take of quail, those who have cooperated have added significant data to our studies that otherwise might not have been obtained. It is hoped that the information presented here will inspire some sportsmen to assist in our studies to such an extent as they are able.

Eye Worm

Thelazia californiensis (Fig. 63, A). This is a small round worm, that, in its mature stages, is found on the surface of the eyeball and under the eyelids. It is approximately half an inch in length. It is white in color and if present can be readily seen when the eyelids are pulled back.

Besides occurring in deer, this worm has been reported from dog, cat, bear, sheep, and, in three cases, from man. As far as is known at present, this worm parasite occurs only in California. The manner by which it is transferred from one animal to another is not known, although experiments seem to indicate it can not be directly transferred by contact. Possibly some insect is involved in the process. In man the worm is readily removed by mechanical means and the patient suffers little more discomfort than he would if he had a cinder in his eye. Apparently none of the human cases that have been reported have been in hunters.

In infected deer there may be only one worm present, but as many as 30 and more have been observed in a single eye. In such heavy cases the infected animal undoubtedly suffers considerably from the irritation and resulting inflammation which causes some impairment of sight. A fuller knowledge of the geographical distribution of this infection in deer might present us with suggestions of a possible transmitting agent.

Foot Worm

Onchocerca cervipedis (Fig. 63, B). This round worm, in its mature stages, is found chiefly under the skin of the feet in the region of the hock. It varies greatly in length from two inches to 10 inches. The male worms are much smaller than the females. The worms are whitish, sometimes coiled up, sometimes extended, and may often be mistaken for a nerve fiber or torn muscle tendons. With careful observation they can be seen when the feet are removed at the time the animal is dressed. These parasites are known only from deer, but also may possibly occur in antelope and elk. The geographic distribution of the parasite is not yet fully known, but it has been observed from several areas in California as well as other western states and southwestern Canada.

The manner of transmission from deer to deer is not known. It is believed that some losses in deer may result from infection with these worms but much further study is needed to determine the extent of such losses. There have been reports of sore feet resulting from the infection which may make it difficult for the deer to forage for food and make them easier victims of predators. Sometimes small open sores are observed on the skin where the worms may be trying to work their way through to the surface.

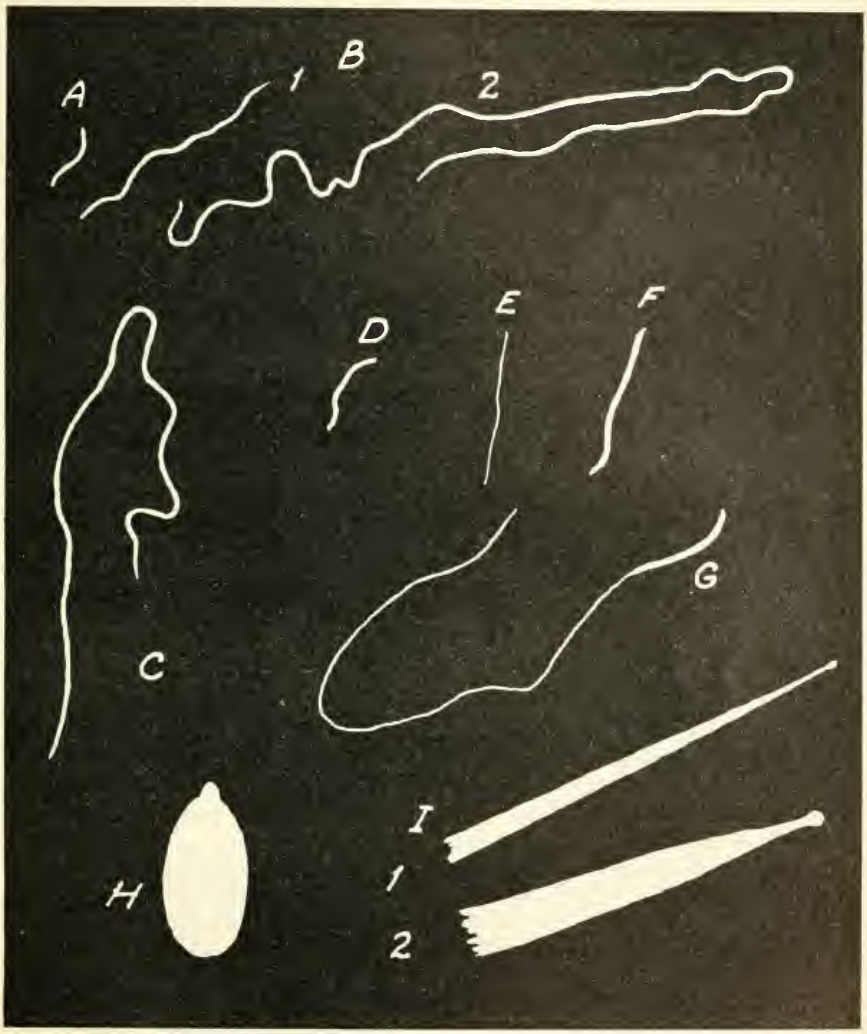

FIG. 63. Diagram showing approximate sizes of some worm parasites from deer: A. eye worm; B, foot worms, 1, male, 2, female; C, body worm (blood worms and lung worms are about the same size and general appearance); D, stomach worm *Ostertagia* (*Trichostrongylus* is about the same size and general appearance); E, stomach worm *Haemonchus;* F, cecal worm *Oesophagostomum;* G, whip worm; H, liver fluke; I, "head" ends of tapeworms, 1, *Moniezia* and 2, *Thysanosoma; Moniezia* tapeworms may become very broad toward the end of the body reaching a width of as much as ¾ inch.

Body Worm

Setaria cervi (Fig. 63, C). This is a long, white, round worm which occurs in the abdominal cavity of the deer. The males are about half as long as the female worms which average about four inches in length. When present in a deer, these worms may be found unattached most anywhere in the body cavity and are often removed along with the entrails when dressing an animal. They may be very numerous.

These parasites, which have been reported from deer in many parts of the world, are also known from cattle and from African antelope, but have not been reported from our pronghorn antelope. They have been shown to be transmitted by stable flies. These worms have never been reported from man. Most workers, who have studied this parasite chiefly as it occurs in cattle, are of the opinion that this worm has no harmful effect on the health of the infected animal.

Blood Worm

Elaeophora schneideri (Fig. 63, C). This is a long, white, round worm which occurs in the arteries of deer. The males are about half as long as the female worms which are approximately four inches in length. In general appearance these worms are much like the previous one described above. The most likely place that a hunter might observe these worms in an infected deer is on the cut surface of the neck when the head is removed from the carcass. The worms may be observed protruding from the arteries.

Besides deer, these worms have been reported only from sheep. Their effect on the animal and manner of transmission is not known. We are aware of very few cases in deer and only one report from sheep so that much is yet to be learned concerning this parasite.

Lung Worms

Dictyocaulus sp. (Fig. 63 C). At least two species of lung worms occur in California deer. These are similar in general appearance. They are round, whitish worms which occur in the windpipe, and in the smaller ramifications of the air passages within the lung tissue. The males are slightly smaller than the female worms which are about three to four inches long. It is necessary to slit open the windpipe and its branches or cut into the lung tissue to observe the presence of these worms.

These lung worms occur in domestic ruminants and are world-wide in their distribution. They do not occur in man. Transmission is direct; that is, no transmitting host is required. The eggs of the worms may hatch in the lungs, but are usually coughed up and swallowed and hatch while they pass through the digestive tract of the deer. Some eggs may be expelled in the nasal discharge (sneezed out) or with sputum (coughed out) but most pass out of the animal with the droppings. After the worms pass through developmental stages on the ground they reinfect deer along with food taken into its mouth. When the young worms have passed the stomachs of a deer they penetrate the tissues and eventually reach the lungs where they mature. In heavy infections these worms are capable of inflicting much damage to deer, especially the younger animals. Damage occurs chiefly in the lungs and the infected animals often die from pneumonia.

Stomach and Intestinal Worms

Ostertagia sp. (Fig. 63, D). These worms occur in the abomasum, or fourth stomach, of deer. They are very small, brownish, round, slender, worms. They occur on the inner wall of the stomach, sometimes in the surface tissue and sometimes buried in small, white nodules or raised

areas. The females are usually less than half an inch in length and the male worms are slightly smaller. These worms can be found by opening the stomach, emptying its contents, and carefully examining the stomach wall.

Haemonchus sp. (Fig. 63, E), often referred to as wire worms, also live on the inner wall of the fourth stomach. The male worms have an even reddish color, while in the female the white ovaries are spirally wound around the red intestines, producing the appearance of a barber's pole. The females average about an inch in length; the males are somewhat shorter.

Trichostrongylus sp. (Fig. 63, D). These parasites are small, slender, pale reddish-brown round worms. They usually live in the first portion of the intestine just back of the fourth stomach, attached to the inner surface. They are approximately the same size as the *Ostertagia* sp.

Ocsophagostomum venulosum (Fig. 63, F). These small, round, white worms occur in the last portion of the intestine, particularly in the large outgrowth known as the caecum. They may be found either attached to the inner wall or free in the contents of this portion of the digestive tract. The females are less than an inch in length, the male worms are slightly smaller.

Because of a number of similarities among the stomach and intestinal worms described above, together with several other related worms not mentioned here, the significance of these worms in deer will be discussed as a unit. This group of worms has without doubt caused more serious inroads in the deer population of the coastal counties of California than have all other parasites together. These worms are all blood-suckers, and by living on the blood of the host cause anemia and thus a general weakening of the infected animal. The greatest harm, and thus the greatest losses, occur chiefly among the younger animals, particularly the yearlings. A frequent symptom is diarrhea, or a condition known as scours.

Most of these worms also occur in sheep and are most prevalent in deer where they share pasture with these animals. Some species also occur in other ruminants and a few rare cases have been reported from man. However, the chances of a deer hunter becoming infected are extremely remote as can be seen from the life-cycle of these parasites discussed in the following paragraph.

The transmission of these worms is direct, requiring no intermediate host. The eggs of the worms pass out of the deer intestine with its droppings. The eggs may hatch before they leave the deer. A period of usually two or more weeks is required before the young stages of the worms can infect another animal. In this stage of development the worms thrive best in a moist habitat. They are extremely small and can be observed only with the aid of a microscope. When ready to infect an animal, they climb up on blades of grass to be eaten.

Intensity of infection in deer seems to be directly proportional to the amount of grazing done by the animal. In areas where the available browse is limited and the deer are forced to subsist almost entirely on grass, intensity of infection and losses are likely to be high. Losses in yearlings are most common in late winter and early spring when there is an abundance of fresh green grass.

Whip Worm

Trichuris sp. (Fig. 63, G). In these round worms the anterior part of the body is long and slender, while the posterior part is much thicker. They may be several inches in length. They live in the cecum of deer with the slender portion of the body usually imbedded in the tissue. The species that occurs in deer is possibly the same as that which occurs in sheep, but probably can not infect man. The life cycle is direct and infection is by mouth. Whether or not these worms cause harm to infected deer is not known.

Liver Fluke

Fasciola hepatica (Fig. 63, H). This parasite has been reported from a great variety of animals including a number of cases from man. It is of chief importance as a parasite of sheep and cattle. It lives in the bile ducts of the liver and in many areas in California the livers of cattle are condemned for human consumption because of infection with this parasite.

The worms are flat and leaflike. In the fresh liver they are reddish and often coiled up in the bile ducts. They can usually be seen oozing from the bile ducts when one slices through the liver. These worms are likely to occur in deer in areas where the infection is common in sheep or cattle. Frequently the appearance of scars on the liver tissue is an indication of the presence of these parasites. Infected livers should be discarded and not used for human consumption.

The transmission of the liver fluke requires a snail as intermediate host. The eggs of the worms pass out of the deer with the droppings. After a period of development, in water, they hatch as a free-swimming stage which seeks out and penetrates a particular species of snail. Further development takes place within the snail after which the parasite leaves this host to become encysted on blades of grass or sink to the bottom of the water. Infection occurs from eating these cysts. The chief method employed in combatting this infection is the elimination of the snail hosts by chemical means. It is not yet known whether this parasite is as harmful to deer as it is to cattle and sheep.

Tapeworms

Moniezia sp. and *Thysanosoma actinoides* (Fig. 63, I). These white, ribbon-like flat worms live in the first portion of the intestine and may attain a length of as much as 200 inches in *Moniezia*. *Thysanosoma* is much smaller, usually less than 12 inches. These parasites, particularly *Moniezia,* may cause young deer to be in poor condition and even cause some losses. The worms occur also in sheep, cattle, and other ruminants but have never been reported from man.

Bladder Worms

Cysticercus, or immature stage of various tapeworms. (Fig. 64.) Tapeworms of the genus *Taenia* usually require an intermediate host. The adult (tapeworm) usually lives in the intestine of a carnivorous

animal or final host, but as an immature stage (bladder worm) in another species of animal or intermediate host, usually an herbivorous one. The eggs from the adult worms which pass out with the droppings of the animal infected with the adult tapeworm are eaten by the intermediate host. The final host becomes infected by eating the tissue of an infected intermediate host.

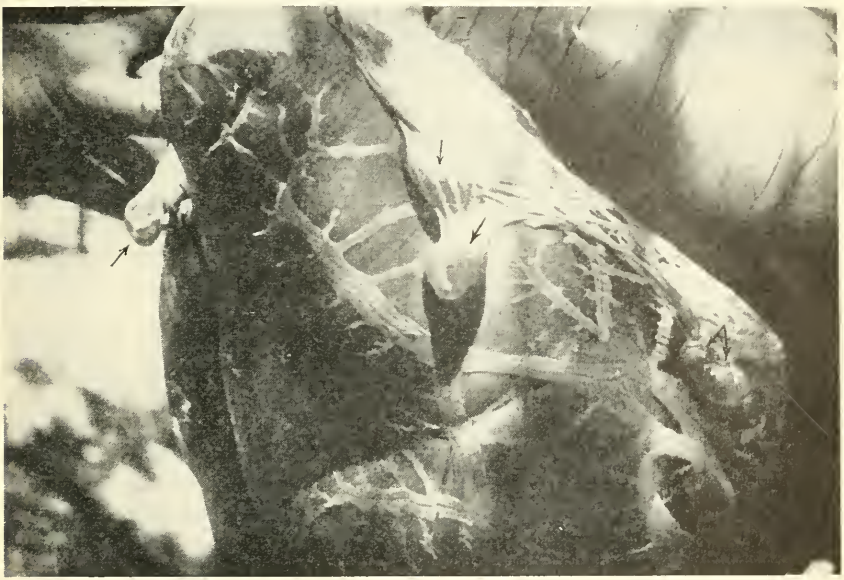

Fig. 64. Bladder worms on membrane covering stomach of deer. (Photo by J. S. Dixon)

Deer serve as intermediate host for several species of these tapeworms. The commonest occurs as whitish cysts, chiefly on the mesenteries, the lace-like membrane that covers the entrails of the deer. They may also occur in the liver. These cysts may vary from the size of a buckshot to that of a small grape. They are thin-walled, contain fluid and a small white body which in the final host becomes the "head" of the tapeworm. The final host of this tapeworm is the coyote or dog. Various other tapeworm cysts occur in deer in other parts of the body. They may occur in heart muscle, lung, or in the flesh. They may be as small as the head of a pin and are always whitish in color. Some of these tapeworms may occur as adults in man, but they are chiefly parasites of cats and dogs. They are readily killed by ordinary cooking procedure so there is no danger in eating cooked meat from an infected animal. However, when cysts (small white spots) occur in the flesh of a deer it would be well not to use this flesh in preparing jerky for human or dog consumption unless the process includes some cooking. The chief concern of the hunter should be to avoid feeding the entrails of his deer to his dog whenever the grape-like cysts occur on the mesenteries or in the liver.

Hunter Cooperation

Hunters wishing to help in the investigation of these parasites can cooperate by collecting specimens from the game which they kill. The round worms can be preserved in 70 per cent alcohol and the liver fluke and tapeworms in 10 per cent formaldehyde. These solutions can be obtained in any drug store. The general rubbing alcohols can serve. Collected specimens can be sent to the Laboratory, Division of Fish and Game, Ferry Building, San Francisco.

EDITORIALS AND NOTES

THE SHARK, *CARCHARHINUS AZUREUS*, IN SOUTHERN CALIFORNIA WATERS

This note is to record a northern extension of the range of the shark *Carcharhinus azureus* (Gilbert & Starks). During September 1942, four specimens of this species were taken in southern California waters. All previous distribution records are from Central American waters. We have received no additional California records up to June 1945.

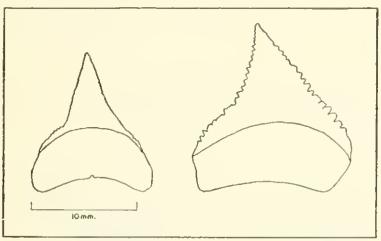

Fig. 65. Teeth from 310 cm. male specimen of *Carcharhinus azureus*.

The species is discussed at some length by Beebe and Tee-Van who refer to the species as *Eulamia azureus* (Zoologica, vol. 26, part 2, pp. 109-110, 1941). The California specimens agree in all respects with their description.

In using the name *Carcharhinus* instead of *Eulamia* we are following general precedent and the advice of Dr. Carl L. Hubbs and Mr. W. I. Follett, both of whom have spent some time untangling the involved synonomy of the genus. Probably the matter will have to be finally settled by the International Commission on Zoological Nomenclature.

Data on the individual specimens follow:

1. Male, 305 cm. total length. Taken in soupfin shark (*Galeorhinus zyopterus*) gill net, set in three to ten fathoms on the south side of Santa Catalina Island between September 10 and 13, 1942. Liver weight, 23 pounds.

2. Male, 310 cm. total length. Taken in purse seine catch of horse mackerel (*Trachurus symmetricus*) one mile off the east end of Anacapa Island, September 17, 1942.

3. Male, about the size of those above. Seen on a purse seiner in Los Angeles Harbor September 18, 1942. As the vessel was leaving the dock at the time, it was impossible to obtain a definite catch locality.

4. Immature female, 197 cm. total length, 82.5 lbs. total weight. Taken in soupfin shark gill net, set in three to ten fathoms on the south side of Santa Catalina Island between September 16 and 20, 1942. Liver weight, four pounds.

Teeth from the 310 cm. male are illustrated in Fig. 65.

These teeth have been turned over to the Natural History Museum at Stanford University. Their museum specimen number is 40091.—*D. H. Fry, Jr. and P. M. Roedel, Bureau of Marine Fisheries, California Division of Fish and Game. June, 1945.*

TWO UNUSUAL FLATFISHES FROM MONTEREY BAY

Within a period of one week, two unusual flatfishes were taken from Monterey Bay. One of these was a California halibut, *Paralichthys californicus,* 20 inches in total length, and the other a starry flounder, *Platichthys stellatus,* 12⅛ inches in total length. Both of these specimens were totally dark on the underside as well as on the top side. In addition, both had an anterior hook to the dorsal fin and one eye incompletely rotated from the opposite side (see Fig. 66). It is not unusual to find a flatfish occasionally with partial coloration on the white or blind side, with no other abnormalities. But, total or almost total ambicoloration accompanied by the above abnormalities is quite rare.

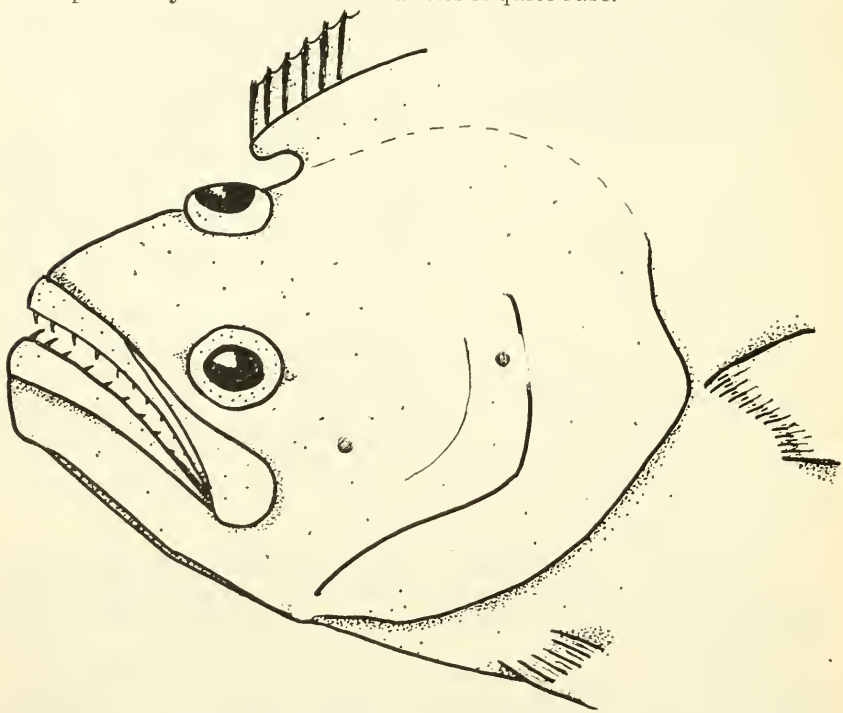

Fig. 66. Top view of head of ambicolored California halibut showing anterior hook to dorsal fin and one eye in partially rotated position. The total length of specimen was 20 inches. An ambicolored starry flounder, 12⅛ inches in total length, taken about the same time and in the same general locality in Monterey Bay showed the same characteristics.

The California halibut was taken in 25 fathoms of water off Moss Landing by the vessel "Falcon" while dragging on December 28, 1944. The starry flounder was taken in the same locality by the vessel "Riso Bros." on January 4, 1945. Both catches were unloaded at the General Fish Corporation, Monterey. Cottardo Loero, manager of the concern, saved the specimens upon noting their peculiarities. The specimens have been turned over to Stanford University for permanent keeping.

E. W. Gudger of the American Museum of Natural History, New York City, has been working on unusual fishes for 17 years. During this

time he has noted a number of flatfishes with partial coloration on the blind side but with no other apparent abnormalities. However, he has noted only a few cases where there was complete coloration, or nearly so, on both sides, accompanied by the hooked dorsal fin and partially rotated eye. The few cases reported by Gudger have been from the Atlantic seaboard.

The complete coloration of both sides of the two flatfishes mentioned may be associated with the incomplete development of the head. That is, development appears to have been arrested at a post-larval stage when pigmentation still persisted, strongly, on both sides. However, this does not explain partial coloration of the under side when development of the head and the rest of the body appears to have been perfectly normal. Nearly all experiments concerning color in fishes show that, in normal animals, paling and darkening of the skin is due to the response of chromatophores to stimuli received through the eyes.—*J. B. Phillips, Bureau of Marine Fisheries, California Division of Fish and Game, May, 1945.*

LATE SPRING SPAWNING OF CHINOOK SALMON *(ONCORHYNCHUS TSCHAWYTSCHA)*

On May 5, 1945, Dr. H. W. Wilkinson of San Jose and I were fishing on the Sacramento River below the U. S. 99 Highway bridge at Redding.

Two dark salmon were noted rising regularly at the same spot on a big riffle. My curiosity was aroused and a spinner was cast out above the two fish. On the first cast a small salmon about 20 inches long followed the spinner almost to shore but refused to take it. This was a different fish from the two observed rising.

On a succeeding cast there was a light strike and the fish hooked at the spot of rising. Very little fight was shown by the fish which was easily brought in and beached in shallow water. As soon as the fish fell over on its side, ripe eggs began pouring out. It proved to be a female Chinook or king salmon (*Oncorhynchus tschawytscha*) about two-thirds spawned out.

This was checked by the count of 16 rays in the anal fin and other characters. I judged the fish to weigh about 14 pounds. The lower portion of the caudal fin was badly frayed and the soft tissue of the anal fin was nearly all gone, leaving the rays exposed. There were many creamy white blotches showing on the rear third of the fish.

She was immediately released and a few minutes later was noted back at the same location in the riffle with the other larger dark fish, which I took to be a male from its general shape although the snout did not appear to be as greatly developed as are some fall run males.

To my knowledge the occurrence of late spring Chinook salmon spawning has not been heretofore reported from the Sacramento River.—*Donald D. McLean, Bureau of Game Conservation, California Division of Fish and Game, June, 1945.*

TWENTY-FIVE YEARS AGO IN CALIFORNIA FISH AND GAME

The leading article in California Fish and Game for October, 1920, was "Distribution of the Golden Trout in California" by S. L. N. Ellis and H. C. Bryant. It covers the years from 1876 to 1919, and tells how members of our Bureau of Patrol, members of the Sierra Club, and interested individuals caught golden trout from the small streams which were their native habitat and transported them by pack stock to other streams and lakes in the nearby High Sierra.

It was toward the end of the period covered by this report that the Division of Fish and Game undertook the artificial propagation of this trout. An egg-taking station was established on the Cottonwood Lakes above Lone Pine, and in 1918 the first successful shipment of eggs was made to the Mt. Whitney Hatchery. Production of trout from this source continued annually through 1941, the policy being to confine distribution to the High Sierra from the Yosemite south, although isolated plants were made in other parts. Barren lakes were utilized wherever possible in order to prevent interbreeding with other species, and in these lakes the golden trout flourished. With the war came limitations on manpower which made operation of the Cottonwood Lakes Station difficult, and at the same time it was felt that the golden trout had so well established themselves in most of the remote, lightly fished waters where they had been planted that stocking was not essential for the time being. Conditions after the war will determine whether it is necessary to resume hatchery production of these fish.

It is now believed that there are not more than two distinct species of golden trout, *Salmo whitei* from Soda Creek tributary to the Kern from the west, and *Salmo aguabonita* from Golden Trout Creek and the headwaters of South Fork of Kern. *Salmo roosevelti* has been shown to be indistinguishable from the latter form, and this name is therefore not valid.

All species of trout have the tendency to vary in appearance under different conditions, and in the golden this is demonstrated in extreme form. In its native Golden Trout Creek it rarely grows over 10 inches in size, and retains throughout life the oval, purplish patches along the side called "parr marks." Transplanted into barren lakes, it may reach a weight of several pounds, and, perhaps as a result of its rapid growth, loses the parr marks at an early age. Fish from the two habitats placed side by side would not be recognized by the uninformed as being of the same species.—*Brian Curtis, Editor,* California Fish and Game, *July, 1945.*

IN MEMORIAM

W. L. HARE

Warden W. Les Hare passed away on July 13, 1945. He had been in poor health for the past several years, and became seriously ill while stationed at Elsinore. Suffering hemorrhages, he was taken to the Riverside Hospital, Riverside, California, where the end came. He was 65 years old.

Les was employed as a warden at various times from 1917 to 1922, and as a full-time warden from 1927 until his death. He was a willing and conscientious worker and intensely interested in all fish and game matters. His funeral was largely attended by employees of the Division in southern California. He leaves a son, Marquis, to whom the Division extends sincere sympathy.—*L. F. Chappell, Chief Bureau of Patrol, California Division of Fish and Game, September, 1945.*

VICTOR E. VON ARX

Warden Victor E. Von Arx died at his home in Santa Rosa on August 21, 1945, at the age of 69. His service with the Division of Fish and Game started in August of 1920 and he had just completed 25 years as a member of the Bureau of Patrol. He would have been eligible for retirement in March of 1946.

Most of his service was in Sonoma and surrounding counties. He was a highly respected citizen of these communities, always friendly, loyal to his organization and regarded as one of the most efficient wardens on the force. His health had not been the best for the past two years, but he carried on a full working schedule until shortly before his final illness.

Very sincere sympathy is extended to Mrs. Von Arx and his family by the Division of Fish and Game.—*L. F. Chappell, Chief Bureau of Patrol, California Division of Fish and Game, September, 1945.*

REPORTS

FISH CASES

April, May, June, 1945

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones: Undersize, for sale, fail to show on demand, bringing ashore above high water mark detached from shell, overlimit, no license	150	$3,990 00	
Angling: Spear 300 feet of stream, closed season, no license, night fishing, gaff hook on spawning riffle American River, using set lines, fail to show license on demand, fishing 150 feet lower side Empire Weir, closed stream, fishing tackle in fish refuge, shipping more than two limits in less than seven days	70	1,435 00	
Bass, black: Closed season, night fishing	30	702 50	10
Bass, striped: No license, using more than one line, buying, overlimit, undersize, retaining bass taken in shad net	38	1,205 00	
Catfish: Undersize, using set lines, selling undersize, no license	6	210 00	
Clams: Undersize, overlimit	10	260 00	
Commercial: Drag net District 19, no license, operate drag net less than 25 fathoms of water, operating gill net closed district, net so constructed as to become a trammel net, operating round haul net District 2, dealing in fish and keeping no records	26	1,105 00	
Crabs: Undersize, female	3	90 00	
Crappie: Closed season	1	25 00	
Frogs: Undersize	1	25 00	
Lobsters: Unpunched during closed season	3	75 00	
Pollution	2	300 00	
Salmon: Snagging, netting before sunset Sunday District 12-B, spearing, undersize, 150 feet below dam	9	310 00	
Sunfish: Closed season, no license, fail to show on demand	32	720 00	
Trout: Closed season, overlimit, using more than one line, no license, selling, other than angling	63	2,065 00	
Totals	444	$12,517 50	10

GAME CASES

April, May, June, 1945

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer: Female, at night, spike buck, spotlighting	11	$1,400 00	
Deer meat: Closed season, illegal, unstamped	13	1,072 50	1
Doves: Closed season	1	100 00	
Ducks: Closed season	2	20 00	
Geese: Closed season	1	25 00	
Grouse	1	35 00	
Hunting: No license, shooting ducks from power boat, shooting from vehicle, shooting from highway, closed season, late shooting	8	202 50	
Meadowlark	3	75 00	
Pheasant: Closed season, hen	11	800 00	
Pigeons: Closed season	1	100 00	
Quail: Closed season, no license	5	167 00	
Rabbits: No license, closed season	7	120 00	
Totals	64	$4,117 00	1

SEIZURES OF FISH AND GAME

April, May, June, 1945

Fish:	
Abalones	577
Bass, black	62
Bass, black, pounds	6
Bass, striped, pounds	77
Catfish, pounds	400
Clams	48
Crappie	43
Perch, saltwater, pounds	50
Sunfish, bluegill	35
Sunfish	167
Salmon	21
Shad, pounds	102
Trout, pounds	25
Trout	502
Trout, rainbow, pounds	10
Trout, rainbow	397
Trout, steelhead	20
Trout, steelhead, pounds	1
Lobster traps	16
Game:	
Deer	5
Deer meat, pounds	175½
Doves	2
Ducks	22
Pheasant	2
Pheasant, male	12
Pheasant, hen	1
Quail	1
Rabbits, cottontails	11
Squirrels, grey	1
Woodduck	1

FINANCIAL STATEMENT—DIVISION OF FISH AND GAME

Revenue for the Period July 1, 1944, to June 30, 1945, of the Ninety-sixth Fiscal Year

Revenue for Fish and Game Preservation Fund:	
License revenue:	
1945 series—	
Angling	$322,795 50
Hunting	153 00
Deer tags	20 00
Fish tags	2,403 00
Game tags	50 80
Market fisherman	62,900 00
Fish importers	60 00
Fish party boat permits	160 00
Fish breeder	270 00
Game management—Tags	8 91
Game breeder	2,620 00
Kelp license	50 00
Total, 1945 series	391,491 21
1944 series—	
Angling	578,991 50
Hunting	614,185 50
Commercial hunting club	900 00
Commercial hunting club operator	250 00
Trapping	1,630 00
Fish packer and shellfish dealer	910 00
Deer tags	178,163 00
Fish tags	1,180 00
Game tags	50 22
Market fisherman	43,850 00
Fish party boat permits	59 00
Fish breeder	35 00
Game breeder	265 00
Kelp license	30 00
Game management—Licenses	160 00
Game management—Tags	41 49
Antelope permits	2,500 00
Pheasant tags	105,811 00
Deer meat lockers	4,962 00
Deer meat wardens	618 00
Total, 1944 series	1,534,591 71
1943 series—	
Angling	2,138 00
Hunting	5,545 50
Deer tags	40 00
Fish tags	27
Market fisherman	200 00
Total, 1943 series	7,923 77
Subrevenue	1,934,006 69
Other revenue:	
Court fines	38,909 88
Lease of kelp beds	998 10
Fish packers tax	339,110 13
Kelp tax	1,474 74
Salmon tax	52,799 07
Miscellaneous revenue	17,297 67
Sale of boat	10,486 00
Total other revenue	461,075 59
Grand total—Fish and Game Preservation Fund	$2,395,082 28

FINANCIAL STATEMENT—DIVISION OF FISH AND GAME

Expenditures for the Period July 1, 1944, to June 30, 1945 of the Ninety-sixth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Education and public information	$3,300 00	$6,329 41		$9 22	$9 638 63
Executive	7,155 02	3,842 80		19 22	11,017 04
Exhibits		102 10			102 10
Fish and game magazine		1,205 38			1,205 38
Library	2,255 00	362 45		304 17	2,921 62
Office	9,928 58	67,054 55		44 55	77,027 68
Total Administration	$22,638 60	$78,896 69		$377 16	$101,912 45
Patrol and Law Enforcement:					
Cannery inspection	$10,551 28	$535 58			$11,086 86
Executive	18,805 00	4,076 08		10 44	22,891 52
Land patrol	245,212 00	99,455 72		105 19	344,772 91
Marine patrol	39,772 74	31,253 05		289 92	71,315 71
Office	9,251 38	1,482 31			10,733 69
Pollution patrol		1,037 92			1,037 92
Total Patrol and Law Enforcement	$323,592 40	$137,840 66		$405 55	$461,838 61
Marine Fisheries:					
Central Valleys Water and Salmon Project	$13,166 26	$7,163 29		$1,183 80	$21,513 35
Executive	8,200 00	1,296 88			9,496 88
Fish cannery audit		4,206 90			4,206 90
Laboratory	5,612 00	1,468 62		73 81	7,154 43
Mackerel	1,230 00	414 35			1,644 35
Office	9,435 45	211 38		5 01	9,651 84
Sardines	6,453 44	573 38			7,026 82
Shark investigation	2,445 00	2,570 52			5,015 52
Shellfish and miscellaneous	2,805 00	373 86			3,178 86
Statistics	18,243 67	7,159 08			25,402 75
Total Marine Fisheries	$67,590 82	$25,438 26		$1,262 62	$94,291 70
Fish Conservation:					
Biological survey	$9,600 53	$1,220 60		$108 79	$10,929 92
Executive	12,010 00	1,621 46			13,631 46
Field	3,465 00	502 36			3,967 36
Fish food unallocated		56,031 96			56,031 96
Fish planting		330 38			330 38
Fish rescue	7,824 84	2,381 21		48 21	10,254 26
Office	8,482 96	492 41			8,975 37
Operating expense unallocated		17 28			17 28
Pollution inspection	1,020 00	217 91			1,237 91
Statistical		843 96			843 96
Structural maintenance		253 79			253 79
Alpine Hatchery		16 44			16 44
Arrowhead Lake Egg Collecting Station		25 13			25 13
Basin Creek Hatchery	5,362 43	2,362 21			7,724 64
Benbow Dam Experiment Station	1,170 00	89 21		4 76	1,263 97
Black Rock Springs Ponds		252 24		8 20	260 44
Bogus Creek Egg Collecting Station		85 00			85 00
Brookdale Hatchery	5,900 16	1,521 55			7,421 71
Burney Creek Hatchery	6,638 14	1,523 17		193 78	8,355 09
Central Valley Hatchery	3,805 64	3,079 40			6,885 04
Claremont		3 69			3 69
Copco Egg Collecting Station		85 00			85 00
Coy Flat		73 39			73 39
Fall Creek Hatchery	4,823 64	503 44			5,327 08
Feather River Hatchery	1,570 84	1,176 01			2,746 85
Fillmore Hatchery	17,931 62	11,077 83		233 39	29,242 84
Fishing Creek Hatchery		150 00			150 00
Hot Creek Hatchery	13,161 86	17,012 15		132 92	30,306 93
Kaweah Hatchery	5,008 51	1,528 23		10 89	6,547 63
Kern Hatchery	2,785 00	1,636 65			4,421 65
Kings River Hatchery	5,607 50	1,994 02			7,601 52
Klamathon Egg Collecting Station		103 14			103 14
Lake Almanor Hatchery	7,349 97	2,211 92		49 15	9,611 04
Madera Hatchery		50 10			50 10
Mt. Shasta Hatchery	41,472 65	11,254 51		2 50	52,729 66
Mt. Tallac Hatchery	2,217 05	2,109 05			4,326 10
Mt. Whitney Hatchery	20,592 65	15,405 19		14 99	36,012 83
Prairie Creek Hatchery	4,615 48	2,100 64		8 71	6,724 83
Rearing Reservoir		1 00			1 00
Rush Creek Egg Collecting Station		51 90			51 90

FINANCIAL STATEMENT—DIVISION OF FISH AND GAME

Expenditures for the Period July 1, 1944, to June 30, 1945, of the Ninety-sixth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued:					
San Lorenzo Egg Collecting Station		$177 57			$177 57
Sequoia Hatchery	$3,490 00	1,662 65		$12 08	5,164 73
Shasta River Egg Collecting Station		585 31			585 31
Snow Mountain Egg Collecting Station	2,847 78	589 88			3,437 66
Tahoe Hatchery	7,737 11	2,883 94		105 71	10,726 76
Upper Truckee		10 00			10 00
Yosemite Hatchery	3,906 08	1,109 97		76 21	5,092 26
Yuba River Hatchery	2,898 16	175 68			3,073 84
Total Fish Conservation	$213,295 60	$148,590 53		$1,010 29	$362,896 42
Engineering:					
Engineering	$11,292 71	$3,530 37		$13 77	$14,836 85
Executive	4,620 00	1,218 51			5,838 51
Inspection fish screens	1,824 03	2,278 22			4,102 25
Office	1,793 74	2 47		3 08	1,799 29
Total Engineering	$19,530 48	$7,029 57		$16 85	$26,576 90
Game Conservation:					
Duck rescue	$147 12	$352 93			$500 05
Elk Refuge	1,855 00	617 84			2,472 84
Executive	10,005 00	2,871 79			12,876 79
Game management	8,856 21	5,875 09		615 40	15,346 70
Grey Lodge Refuge	4,280 11	670 02		38 70	4,988 83
Honey Lake Refuge	3,770 98	2,502 84		1,362 14	7,635 96
Imperial Refuge	2,255 00	186 21			2,441 21
Los Banos Refuge	4,380 00	1,405 31		217 30	6,002 61
Office	4,520 56	229 85			4,750 41
Predatory animal hunting	4,900 00	6,118 14			11,018 14
Predatory animal trapping	42,371 98	16,737 98		584 00	59,693 96
Research	8,268 14	3,150 56		13 94	11,432 64
Statistics		309 02			309 02
Suisun Refuge	3,828 88	1,231 08		1,941 83	7,001 79
Winter Feed		211 90			211 90
Total Game Conservation	$99,438 98	$42,470 56		$4,773 31	$146,682 85
Game Farms:					
Castaic Farm	$1,650 00	$296 40			$1,946 40
Chino Farm		9 87			9 87
Executive	4,225 00	239 69			4,464 69
Fresno Farm	4,161 18	1,621 22			5,782 40
Game Bird Distribution	1,707 14				1,707 14
Game Bird Distribution—Los Serranos		77 34			77 34
Game Bird Distribution—Yountville		73 35			73 35
Game management		17 81			17 81
Los Serranos Game Farm	9,214 19	5,752 47		35 20	15,001 86
Office	1,660 33				1,660 33
Redding farm	2,119 66	1,878 90			3,998 56
Sacramento State Farm	3,284 80	1,067 27			4,352 07
Visalia	338 71				338 71
Willows	1,045 94	814 75		211 41	2,072 10
Yountville boarding house	890 00	2,547 81			3,437 81
Yountville Game Farm	16,648 23	9,916 49		7,225 45	33,790 17
Total Game Farms	$46,945 18	$24,313 37		$7,472 06	$78,730 61
Licenses:					
Executive	$4,460 00	$854 32			$5,314 32
License distribution	20,559 83	89,682 61			110,242 44
Office	1,810 63	1,918 53		$1 59	3,730 75
Total Licenses	$26,830 46	$92,455 46		$1 59	$119,287 51
Grand total					$1,392,217 05

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